

ACHARYA N. G. RANGA AGRICULTURAL UNIVERSITY



**GODAVARI ZONE
PRODUCTION RECOMMENDATIONS FOR
KHARIF & RABI 2022-23**

**Regional Agricultural Research Station
Maruteru– 534 122, West Godavari (AP)**

Crop wise Production Recommendations for *Kharif & Rabi*, 2022-23

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Rice (*Oryza sativa* L.)

Varieties Recommended for *Kharif*

Situation	Varieties for Godavari Zone
Kharif Normal Plantings	Swarna, Indra, Amara, Bheema, Samba Mahsuri, Varam, Ksheera, Maruteru Samba, Maruteru Mahsuri, Sujatha, MTU Rice 1281, MTU Rice 1212
Kharif Aged Nursery (Aged seedlings)	Swarna, Indra, Amara, Maruteru Mahsuri, Ksheera
Low land submerged areas	Badava Mahsuri, Bheema, Amara, Ksheera
Saline soils	Indra, Panduranga
Late kharif plantings	Cotton Dora Sannalu, Tarangini, Chandra, Sri Druthi, Sravani, Pushyami, Vijetha, MTU Ricer 1280
Irrigated dry situation	Cotton Dora Sannalu, Tarangini, Chandra, Sujatha, Varsha
BPH prone areas	Indra, Amara, Maruteru Samba, Maruteru Mahsuri, MTU Rice 1281

Varieties Recommended for *Rabi*

Situation	Varieties for Godavari Zone
Rabi Normal Plantings	Cotondora sannalu, Prabhat, Nellore Mahsuri, Tarangini, Chandra, Sri druthi, Sujatha, Nellore Dhanyarasi, Swetha,
Saline soils	Nellore Mahsuri, Somasila, Nellore Dhanyarasi, Swarnamukhi
Late Rabi plantings	Cotondora Sannalu, Tarangini, Chandra, Nellore Dhanyarasi, Swetha.
BPH prone areas	Cotondora Sannalu, Tarangini, Chandra, Sri druthi

Brief Description of Varieties

Variety	Duration (days)	Yield (T/ac)	Pest/ Disease Resistance	Special Features
Samba mahsuri (BPT 5204)	145 - 150	2.8	-	Fine grain, Excellent cooking quality
Swarna (MTU 7029)	150	3.0	BLB	Fine grain, high yield with low nitrogen
Indra (MTU 1061)	150	2.5	BPH, BLB	Fine grain, non lodging, suitable for raw rice
Amara (MTU 1064)	150	2.5	BPH, BLB	Non lodging, medium slender grain, tolerates submergence in vegetative phase
Pushyami (MTU 1075)	135	2.5	BPH, BLB	Long slender fine grain, Non lodging. Suitable for exports
Sujatha (MTU1210)	125 (<i>Rabi</i>) 135 (<i>Kharif</i>)	2. 6-2.8 2.8-3.0	Tolerant to BPH and Blast	Medium slender fine grain type
Vijetha (MTU 1001)	120 (<i>Rabi</i>)	2.5	BPH, Blast	Medium grain
Bheema	145	2.5	BPH	Medium grain. Tolerates

(MTU 1140)				submergence for 10 days during vegetative phase
Maruteru Samba (MTU 1224)	135-140	2.6-2.8	Moderately resistant to BPH and blast	Strong culm, semi dwarf and semi erect plant type with low shattering.
Maruteru Mahsuri (MTU 1262)	155	2.6-2.8	BLB & BPH	Non lodging, low grain shattering.
Sravani (MTU 1239)	140	2.6-2.8	BPH (T)	Non-lodging
Cotton dora sannalu (MTU 1010)	125	3.0	BPH, Blast (T)	Super fine grain, Suitable for exports
Tarangini (MTU 1156)	120	3.0	Blast, BPH	Long slender, suitable for export
Chandra (MTU 1153)	115	3.0	Blast, BPH	Long bold, high head rice
Sri Druthi (MTU 1121)	125	3.0	BPH, Blast	Medium slender grain with good cooking quality
Prabhat (MTU 3626)	130	3.2	Blast	Non lodging, Bold grain
Ksheera (MTU 1172)	150	2.4	Blast & BLB (T)	Stagnant Flood tolerant, Brown glume, MS grain.
Varam (MTU1190)	140-145	2.6	Tolerant to neck & leaf blast and BLB	Fine grain variety with good cooking quality
Varsha (MTU 1223)	150	2.4	Moderately tolerant to BLB and blast	Medium slender grain, brown glume, suitable for rainfed shallow low lands
MTU Rice 1212	140	2.8	Moderately resistant to leaf blast, neck blast, sheath blight, sheath rot and BLB	Non lodging and nitrogen responsive, fine grain variety
MTU Rice 1280	135	2.8	Moderately resistant to neck blast, rice tungro disease, stem borer and leaf folder	Non lodging and fertilizer responsiveness variety
MTU Rice 1281	140	2.8	Moderately resistant to neck blast, leaf blast and BPH	It is a nitrogen responsive variety with low shattering
Somasila (NLR 33358)	105-110	2.5	Blast	Super fine grain
Swetha (NLR 40024)	120-125	2.8	Tolerant to blast	Non-lodging and heat tolerant, Medium bold, straw glume.
Swarnamukhi (NLR 145)	130-140	2.4	Resistant to blast, tolerant to moisture stress & salinity	Long slender, straw glume
Nellore Dhanyarasi (NLR 3354)	120-125	2.8	Tolerant to leaf and neck blast	Non-lodging, photo insensitive,

Nellore Mahsuri (NLR 34449)	125	3.0	Blast	Non lodging, dwarf, High fertilizer responsive, fine grain variety.
Badava Mahsuri (PLA 1100)	155	2.5	--	Fine grain, good cooking quality, no dormancy
Pandu Ranga (MCM100)	140-145	2.4	Salinity tolerant	medium slender straw glume grain, non-Lodging, Semi-dwarf,

Sowing Nurseries & Seed Rate

- Sowing Up to June 30th during Kharif and December 15th for Rabi
- For Nursery transplanting: 20Kg, for dry seed nurseries 25Kg, For Direct seeding 10Kg, for Direct Seeding with Gorru - 15 Kg.

Seed dormancy:

- For breaking of seed dormancy of varieties with 2-3 weeks dormancy, 6.3ml concentrated nitric acid in 1 lit of water and for varieties having strong dormancy like Vijetha, 10ml of concentrated nitric acid in 1 lit of water should be used. The seeds are to be soaked for 24h followed by 24 h incubation.

Nursery Management (Wet)

- Select an area of nursery, which has good irrigation and drainage facility.
- Prepare the nursery field one month before sowing
- Prepare nursery field by ploughing twice in the summer subsequently by puddling 3-4 times at an interval of 5-6 days.
- Level the field after final puddling and prepare raised beds of one-meter width and of convenient length duly forming channels for irrigation and proper drainage.
- Apply Well-decomposed FYM/ compost @ 200 kg/ 5cents nursery to improve soil condition.
- Soak the paddy seed for 16-24 hours and incubate for 24-36 hours before sowing of sprouted seed.
- Apply 2 kg Nitrogen (4.4 kg of Urea), 1 kg of 'P₂O₅' (6.25 kg of SSP) and 1kg of 'K₂O' (1.6 kg of MOP) for a nursery bed of 5 cents (200 m²).
- Apply total 'P' & 'K' fertilizers and ½ 'N' as basal (before final leveling and thoroughly mixed in the soil).
- Apply the remaining ½ 'N' at 10-15 days after sowing depending up on seedling growth.
- Sow the sprouted seed @ 5 kg/cent (40 m²) of nursery bed and 20 kg seed is sufficient for one acre of main field.
- Broadcast sprouted seed uniformly in seedbeds by keeping thin film of water and drain the water next day morning for proper aeration.
- Maintain alternate wet and dry situation during first week, after that beds can be flooded with water upto 2-3 cm depth depending upon height of seedlings.
- Apply@ 75 ml Benthocarb or Pretilachlor with safener @ 40 ml or Butachlor @ 50 ml or Pyrazosulfuron ethyl @ 5 g in 10 litres of water as pre-emergence application for five cents of nursery to overcome weed problem
- Apply *Cyhalofop P butyl* @ 20 ml/ 10 litres of water at 12-15 DAS to control *Echinochloa spp.* effectively.
- At the time of uprooting, the nursery should be flooded two days before to avoid root damage

Main Field

- Plough the soil once or twice in mid summer prior to main field preparation, it will help in checking the weed growth by exposing the root system of weeds. It also exposes egg masses and hibernated stages of different pests and diseases to the hot Sun and helps soil to retain moisture received during summer.
- Under canal irrigation green manuring is very much suggested
- Initiate puddling at least 15 days before transplanting
- Tractor / power tiller puddling to a depth of 15 cm is enough.
- Level the field perfectly after final puddling and allow it to settle for 2-3 days before transplanting in heavy soils which helps in better water and weed control.
- Transplant 30 days old rice seedlings during Kharif and 20-25 days old seedlings for Rabi.
- Avoid usage of over aged seedlings for transplanting in rice as use of 60 or more days for long duration while more than 40 days for medium duration and more than 30 days for short duration varieties reduces the yield drastically.
- Transplant 33 hills/m² during Kharif and 44 hills/m² during Rabi at 2-3 cm depth @ 2-3 seedlings /hill
- In less fertile soils and in the case of over aged seedlings, transplant 44 hills / m² to reduce the yield loss to some extent.
- Make 20 cm alleyways at every 2 meters apart to facilitate free aeration and for uniform application of fertilizers, Weedicides and pest management practices.

Water Management

- Proper water management facilitates good tillering, increased nutrient use and reduce weed infestation.
- Maintain shallow depth of water (1-2 cm) at the time of transplanting.
- Increase the water level up to 5 cm depth after transplanting till crop establishment
- Maintain shallow depth of water (2-3 cm) during tillering phase of crop.
- Maintain 5 cm of water during panicle initiation to physiological maturity (10 Days before harvest) of the crop.
- Crop should not face water stress at panicle initiation, flowering, milk and grain hardening stages.

Nutrient Management

Recommended Fertilizers for Different Agro-Climatic Zones of A.P

Zone	Kharif (kg/acre)			Rabi (kg/acre)		
	N	P	K	N	P	K
Godavari zone	36	24	24	72	36	24

- Soil fertility and productivity of rice can be improved and maintained through integrated use of organic, inorganic and bio fertilizers in a balanced manner.
- 25-50% of recommended N through Green manures/compost /FYM/ poultry manures results in sustainable yields.
- Green manuring insitu with Sesbania / Crotalaria / Pillipesara or grain legume crop residues like black gram/ green gram can sustain the soil fertility and productivity.
- Bio fertilizers like blue green algae, Azolla, Azospirillum, Phosphobacteria can save about 10 – 20 % 'N' & 'P' requirement of rice crop.

- Apply N, P₂O₅ and K₂O @ 36: 24: 24 kg /acre during *kharif* for varieties other than Swarna. Apply N, P₂O₅ and K₂O @ 24:16:16 kg/acre for Swarna variety. Apply 72: 36: 24 kg /acre during *rabi*. Apply entire 'P₂O₅' & 'K₂O' as basal while 'N' in three equal splits (Basal + Active tillering + Panicle initiation stage). In light textured soils apply 'K₂O' in two splits half at basal and half at panicle initiation along with 2nd top dressing of 'N'.
- Drain out the field before N top dressing and irrigate the field after 2 days only.
- Avoid top dressing of Phosphorus or Phosphorus containing complex fertilizers after 15 days of planting.
- Apply Zinc Sulphate @ 50 Kg / ha to avoid the Zn deficiency. Deficiency in the standing crop can be corrected by spraying zinc sulphate @ 0.2% (2 g /L of water). The spraying should be repeated at 5 days interval depending on the severity of the problem.
- If Iron deficiency is noticed Spray Ferrous sulphate @ 20-25 g with citric acid @ 2-2.5 g/L. 2-3 sprays at 5-day interval are needed.

Weed Management

- The crop should be maintained weed free especially till 45 DAT.
- Hand weeding at 20 and 40 days after transplanting in areas where sufficient manual labour is available
- To overcome weed problem, apply any one of the following herbicides keeping thin film of water. Butachlor @ 1.25 litres /acre (or) Anilophos @ 500 ml/acre (or) Pretilachlor @ 600 ml /acre (or) Oxadiargyl @ 40 grams (mixed with one litre of water) within 3 to 5 days after transplanting or spray Pyrazosulfuran ethyl @ 80-100 g/ acre at 8-12 DAT or Bensulfuron methyl + pretilachlor @ 4 kg/acre as early post emergence (3-15 DAT) or Triafamone 20% + Ethoxysulfuron 10% WG @ 45g/acre. Apply 2,4- D Sodium salt @400 g / acre to control broadleaved weeds or Bispyribac-sodium @ 80-100 ml /acre or metsulfuron methyl 10% + chlorimuron ethyl 10% WP @ 8 g/acre *as* post emergence at 20-25 DAT to control mixed weed population.

Insect Pests and Diseases

Cultural Practices Recommended for Reducing the Build up of Insect Pests

- Summer ploughing
- Grow suitable resistant varieties
- Use recommended doses of fertilizers
- Clipping of the leaf tips of seedlings while planting
- Adopt normal spacing
- Formation of alleyways.
- Alternate wetting and drying
- Weed management

Economic Threshold Levels of Insect Pests

S. No.	Insect Pest	Stage of the Crop	Economic threshold level
1.	Stem borer	Nursery and Tillering	One adult or one egg mass per one sqm or 5% of dead hearts per sqm.
2.	Gall midge	Nursery and Tillering	One silver shoot per hill or 5% galls per sqm.
3.	BPH/WBPH	Tillering	10-15 insects per hill
		After Flowering	20-25 insects per hill

4.	Leaf folder	All stages	One to two damaged leaves per hill
5.	Hispa	Tillering stage	Two adults per hill or two damaged leaves per hill
6.	Green leaf hopper	Nursery	One or two insects per sqm
		Tillering	10 insects per hill
		Flowering	20 insects per hill
7.	Gundhi bug	Flowering	One to two adults per hill

Chemical Control

S. No.	Pest	Stage of the crop	Insecticide	Dose
1.	Gallmidge, Stemborer, Jassids, Hispa, Swarming caterpillar and Thrips	Nursery	Spray Monocrotophos 36 SL/ Chlorpyriphos 20 EC / Profenophos at 10 days interval starting from ten days after germination on need basis. Apply Carbofuran 3G at seven days before pulling up of the nursery.	1.6 ml/lit 2.5 ml/lit 2 ml/lit 160g/cent of nursery
2.	Gallmidge	Tillering	Apply Carbofuran 3G at 15 DAT. (or) Spray Chlorpyriphos 20 EC	25 kg/ha 2.5 ml/lit
3.	Stem borer	Tillering	Spray Monocrotophos 36 SL or Chlorpyriphos 20 EC Chlorantiniliprole 20 SC	1.6 ml/l 2.5 ml/l 0.3ml/l
		Panicle initiation to booting	Spray Cartap hydrochloride 50 SP/ Acephate 75 SP/ Profenophos 50 EC / Chlorantraniliprole 20 SC (or) Apply Cartap hydrochloride 4G/ Carbofuran 3G Fipronil 0.3G When the adult moths/egg masses @ one/sq.m are noticed in the field.	2.0 g/l 1.5 g/l 2.0 ml/l 0.4 ml/l 8 kg/acre 10 Kg/acre 8kg/acre
4.	Leaf folder	Tillering	Spray Profenophos 50 EC / Chlorpyriphos 20 EC/ Monocrotophos 36 SL Chlorantiniliprole 20 SC	2.0 ml/l 2.5 ml/l 1.6 ml/l 0.3 ml/l
		Panicle initiation to booting	Spray Cartaphydrochloride 50 SP Acephate 75 SP/ Chlorantiniliprole 20 SC	2.0 g/l 1.5 g/l 0.3 ml/l
5.	Hispa	Tillering	Spray Profenophos 50 EC/ Chlorpyriphos 20 EC/ Monocrotophos 36 SL	2.0 ml/l 2.5 ml/l 1.6 ml/l
6.	Leaf mite	Tillering	Spray Dicofol 18.5 EC/ Wettable sulphur @ 3 g or	5.0 ml/l 3.0 g/l

			Profenophos 50 EC	2.0 ml/l
7.	Plant hoppers	Panicle initiation to post flowering	Spray Acephate 75 SP/ Monocrotophos 36 SL/ imidacloprid +ethiprole 80 WG Pymetrozine 50 WG Dinotefuran 20 SG Triflumezopyrim 10 SC <ul style="list-style-type: none"> • Use 200 lit of Spray fluid/acre • Spray should be directed towards the base of the plant. • Avoid spraying of combination of insecticides and synthetic pyrethroids. • Alternate the chemicals if another spray required 	1.5 g/l 2.2 ml/l 0.25 g/l 0.6 g/l 0.4 g/l 0.48 ml/l
8.	Panicle mite	Panicle initiation to booting	Spray Profenophos 50 EC/ Dicofol 18.5 EC	2.0 ml/l 5.0 ml/l
9.	Climbing cutworm	Post flowering	Spray Chlorpyriphos + DDVP 76 EC Monocrotophos + DDVP 76 EC <ul style="list-style-type: none"> • Spray in the evening hours 	2.5 ml+1ml/l 1.6 ml+1ml/l
10.	Mealy bug	Panicle initiation to booting	Spray Oxy demeton methyl 25 EC /	2.0 ml/l
11.	Gundhi bug	Milky stage	Spray Chlorpyriphos + DDVP <ul style="list-style-type: none"> • Spray the insecticide from borders to centre of the field. 	2.0 ml+1.0 ml/l

Rice Diseases

Disease	Time of application	Fungicide	Dose	No. of applications & time interval
Sheath blight	At the initiation of the disease. Normally around 30 days after transplanting in <i>kharif</i> and 45 days after transplanting in <i>rabi</i>	Hexaconazole 5EC Validamycin 3L Propiconazole 25 EC Trifloxystrobin + Tebuconazole 75 WG Azoxystrobin 11% + Tebuconazole Azoxystrobin 25SC	@ 2.0 ml/l @ 2.0 ml/l @ 1.0 ml/l @ 0.4 g /l @ 1.5 ml/l @ 1.0 ml/l	2 sprays at 15-day interval
Blast a) Leaf blast	At the initiation of the disease under favourable weather conditions	Tricyclazole 75 WP/ Isoprothiolane 40 EC Kasugamycin 3L	@ 0.6 g/l @ 1.5 ml/l @ 2.5 ml/l	2 to 3 sprays depending on the severity & spread of the disease at 15 days interval
b) Neck	Just before panicle	Tricyclazole 75 WP/	@ 0.6 g/l	One spray

blast	emergence under favourable weather conditions	Isoprothiolane 40 EC	@ 1.5 ml/l	
	After emergence- on panicle emergence	Tricyclazole 75 WP/ Isoprothiolane 40 EC Kasugamycin 3L	@ 0.6g/l @ 1.5 ml/l @ 2.5 ml/l	One spray
BLB	---	No chemical available. Management is mainly through rationalization of nitrogenous fertilizer application and water management in the field	---	---
Stem rot	At the appearance of the disease (Normally from maximum tillering to crop maturity stage)	Validamycin 3L / Hexaconazole 5EC / Propiconazole 25 EC / Tebuconazole 25.9 EC	@ 2.0 ml/l @ 2.0 ml/l @ 1.0 ml/l @ 2.0 ml/l	2 to 4 sprays at 10-15 days interval depending on the severity and spread of the disease
Red stripe	At the appearance of the disease from advanced boot leaf to crop maturity stage	Carbendazim 50 WP	@ 1.0 g/l	One spray
Sheath rot	At the appearance of the disease or at panicle emergence stage	Propiconazole 25 EC	@ 1.0 ml/l	One spray
False smut	At 50% panicle emergence and flowering stage	Propiconazole 25 EC/	@ 1.0 ml/l	One spray during evening hours
	Seed borne disease- seed treatment	Carbendazim 50 %WP /Carbendazim 25 %WP + Mancozeb25%	@ 1.0 g/l @ 2.0 g/l	At the time of sowing

Rodent Control

For Endemic Areas

- Destruction of rodent harborage.
- Reducing the number and size of field bunds
- Complete the sowing and planting uniformly and avoid staggered sowings and plantings.
- From puddling to one month after planting, setup local traps @ 20 /acre.
- Installation of permanent bait stations from planting to flowering stage @ 5 /ha. Four at four corners of the field one meter inside the cropped area from the field bund and one at the centre, Bromadiolone bait @ 30 g per bait station should be replenished twice in a week.
- Baiting with bromadiolone 0.005% prior to primordial initiation stage of the crop on community basis
- From primordial initiation to crop harvest, smoking of burrows with “burrow fumigator” developed by RARS, Maruteru.

Management of Rodents with Bromadiolone 0.005%

- Identify live burrow counts (LBC) and place 15 gm freshly prepared bromadiolone (0.005%) loose bait (92 parts broken rice+2 parts edible oil+ 2 parts bromadiolone powder) in packets inside the burrow when LBC is above 25 per ha
- Repeat bromadiolone (0.005% poison) loose baiting in the active /live burrows as and when the incidence is above ETL.

Management of Rodents with Zinc Phosphide 2%

- When the rodent incidence is very high (>50 LBC/ha) practice ZNP poison baiting once in a crop season before P.I stage.
- Pre-bait the burrows with 20 g plain bait without poison one day before the actual poison baiting to overcome bait shyness. Next day, the live burrows may be applied with 10-15 g of 2% ZNP poison bait (*96-parts broken rice: 2 parts edible oil: 2 parts ZNP powder*) packets.

Ecologically based non-chemical rodent management through Trap Barrier System (TBS):

- Erect 2 ft height polythene sheet barrier around the crop at 15 days after transplanting.
- The polythene barrier is provided with 3inch radius holes above the water level at 15-30 m distance and wonder traps are arranged firmly inside the crop, their entry mouths matching the holes made in the polythene sheet.
- Arrange a soil moat before the entry hole to facilitate the animal to enter easily inside the trap
- Maintain water around the TBS and collect the successful traps every day and replace with new / emptied traps

Application of ALP tablets:

- When rodent incidence is very high, apply 6% ALP tablet (each tablet weighs 12g) (Ratox^R) one per burrow and close the burrow with wet/ mud soil

Note: Control schedules should be executed on community basis to check cross infestation through migration.

Harvesting and Storage

- Harvesting should be done when at least 80 % of the grains are matured. If the crop is harvested without proper maturity it leads to loss of viability of grains and broken in milling.
- The harvested material should be dried in the field for 2-3 days.
- The grain should be free from inert material after threshing and winnowing.
- The winnowed grains should be sun dried until the moisture content reaches < 13%.
- Both over drying and under drying will lead to breakage of the grain during processing.
- High moisture content during storage leads to loss of viability due to increased grain respiration and increased attack of storage insects and pests.

MAIZE (*Zea mays* L.)

Recommended Varieties

Hybrids

Long duration (100-120 days): DHM 113, P 3396, P 3546, P 3302, DKC 9120, DK 9133, DK 9144, NK 7720, NK 30, Kaveri bumper, Bharati 99, NMH 713, PAC 751, **Kargil 900 M Gold, 30 B 07**, NK-30, **Bio 9682, NK 6240, Pro-311**, MCH 36, SMH 3904, JKMH 2492, SeedTech 2324, Bisco 97 Gold, P3522, P 3580 and Pioneer 30V92.

Medium duration (90-100 days): DHM 111, **DHM 117**, DHM 119, DHM 121, Kohinoor, Prabhal, Bisco 855, JKMH 175, **Bio 9637, Bio 9544**, MCH 2, KH 510, KH 9541, KMH 25K60, S 6217, HM8, NMH 1242, NSCH 12, DKC 8171 and HM10.

SPECIALTY CORN

Hybrids

Sweet corn: Sugar 75, Bright Gene

Popcorn: BPCH 6

Baby corn: HM 4, DHM 115, **Prakash, HIM 128**, HIM 129, PEHM-1 & PEHM-2, PEHM 3, JH 3459, Vivek hybrid 9, VL 42 and Deccan 1.

Quality protein: HQPM-1, HQPM-4, HQPM-5, HQPM-7, Vivek QPM 9

Varieties

Sweet corn: **Madhuri, Priya**, Win Orange, Almora sweet corn and Sakata 16.

Popcorn: Amber popcorn, Pearl popcorn, VL popcorn

Baby corn: **VL 42**, Him 123, **Him 129**, Madhuri, VL78, JH 3459, VL Baby corn 1, Kanchan, and Surya.

Land preparation and Soils

- One deep ploughing with mould board plough followed by ploughing with wooden plough twice or thrice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better insitu moisture conservation.
- Red sandy loam and medium black soils with good drainage facilities are preferable.

Seed treatment: Seed treatment with Captan or Mancozeb @ 3 g/kg of seed.

Sowing time

Kharif: June 15th to July 15th Rabi: October 15th to November 15th

Summer: 15th Jan to Feb 15th Zero tillage: Up to December

Seed rate and Spacing

8 kg per acre for normal hybrids 4 kg per acre for sweet corn
5 kg per acre for pop corn 10 kg per acre for baby corn.

Fertilizer doses and time of application

FYM 10 t/acre

Type	<i>Kharif (Kg/acre)</i>			<i>Rabi (Kg/acre)</i>		
	Nitroge n	Phosphorou s	Potash	Nitroge n	Phosphorou s	Potash
Hybrids	80	25	20	100	35	35
Sweet corn	75	25	20	80	25	20
Pop corn	35	25	20	40	25	20
Baby corn	50	20	20	75	25	20

Kharif

- 1/3 N + entire P₂O₅ + ½ K₂O (basal)
- 1/3 of N at 30-35 DAS (knee high)
- 1/3 of N at 0-55 (Tasseling), ½ K₂O

Rabi

- 25% N + entire P₂O₅ + K₂O (basal)
- 25% of N at 25-30 DAS (knee high)
- 25% of N at 45-50 (Pre-tasseling)
- 25% of N at 60-65 DAS (Tasseling)

20 kg of commercial zinc sulphate per acre may be applied if soils are known to be deficient in available zinc. If deficient symptoms appear later, the crop can be sprayed with 0.2% (2g/l) solution of zinc sulphate.

Weed control: Pre-emergence spraying with Atrazine 50 W.P. @ 800g - 1.2 kg/acre (4 g/l) depending on soil type effectively controls most of the broad-leaved weeds for about 3-4 weeks. Alachlor 50% @ 3.75 to 5 l/ha or oxyfluorfen 23.5% @ 500 ml/ha also are used as pre-emergence herbicides. In intercropping system involving legume crops, pre-emergence application of pendimethalin 30% EC @ 1.0 l/acre in 200 lit of water (5 ml/l) is recommended. As post emergence application at 20-25 days of crop period or 4 leaf stage of weeds, spraying of Atrazine (same dose) or 2,4-D Sodium salt 80 WP @ 400g or Tembotrione @ 120 ml + Atrazine 400g or Halosufuron @ 40 g/acre in 200 lit of water will effectively control weeds. Or spray topramezone 33.6% @ 75 ml/ha or tembotrione 34.4% SC @ 286 ml/ha to control grassy and dicot weeds. After 30-35 days, crop may be inter-cultivated and earthing up is done.

Inter crops: 2:1 Maize: Redgram

Major pests and diseases control:

Pests

Stem Borer and Pink borer

- In endemic areas, prophylactic spraying of Monocrotophos 36 SL @ 1.6 ml/l or Chlorantriliprole 20 SC @ 0.3 ml/l when the crop is 10-12 days old and or application of Carbofuran 3 G in leaf whorls @ 3 kg/acre is recommended when the crop is 25-30 days old.

Shoot fly (*Atherigona sp.*)

- Sowing must be completed before first week of February so that the crop will escape shootfly infestation.
- Spring sowing must be accompanied with seed treatment with Imidacloprid @ 6ml/kg seed.

Fall Army worm (*Spodoptera frugiperda*)

- Installation of pheromone traps @ 10/acre before sowing to forecast the pest.
- Seed treatment with Cyantriliprole @ 19.8% + Thiomethaxam @ 19.8% or 4 ml/kg seed.
- Egg masses and larvae should be handpicked and destroyed.
- Releasing Trichogramma and Telenomus on crop.
- Spraying of 5% (5ml/l) neem oil to control egg masses and first instar larvae or spraying of chlorpyrifos 25 EC 400 ml or Quinolphos 25EC 400ml in 200 liters of water per acre (2ml/l). The spray should be directed into whorls.
- When the infestation is heavy, emamectin benzoate 5SG @80g (0.4g/l) or Spinosad 45SE @60ml (0.3ml/l) in 200 lit of water should be sprayed per acre.
- Poison baiting is effective in controlling later instar larvae. 10 kg rice bran + 2kg jaggery in 2 lit of water are mixed and fermented for 24 hrs. Next day 100g Thiodicard is mixed and dropped in the whorls of the plants.

Diseases

Maydis leaf blight

- Spray mancozeb 2.5g/l at knee high stage
- Seed treatment with captan/thiram @ 4g/kg

Turicum leaf blight: Spray Mancozeb (2.5g/l)

Rust: Spray mancozeb (0.25%) starting when pustules first appear.

Banded leaf and Sheath blight

- The disease can be minimized by plucking lower leaves
- Spray Carbendazim at 1 g/l or Propiconazole 1ml/l

Seedling blight, root and stalk rot

- Crop rotation, field sanitation and avoiding water logging
- Seed treatment with Metalaxyl 4g/kg or captan 3g/kg
- Drenching the soil with captan @ 1.5 g/l copper oxy chloride @ 3g/l or Metalaxyl @ 3g/l.

Charcoal rot

- Field sanitation, crop rotation and avoiding moisture stress by providing regular irrigation particularly at flowering reduces disease incidence
- Irrigate the crop at the time of ear head emergence to maturity.
- Apply 80 kg potash fertilizer per ha.

Late wilt: Crop rotation and avoiding water stress at flowering

Irrigation schedule along with critical stages

Four to six irrigations are needed for maize crop. If six irrigations are given, they should be applied at the following crop growth stages. Two irrigations up to flowering at an interval of 20-25 days, one at the time of flowering, two after flowering and one at the early grain filling stage. If five irrigations are given, one irrigation at the vegetative stage may be skipped and if only four irrigations are given, one irrigation after the dough stage may be skipped.

Rice-fallow Maize under zero tillage

- Sowing time is November to January in Coastal Andhra Pradesh.
- No preparatory tillage is done
- Seed rate: 3 kg/ac. Dibble 3-4 seeds after harvesting *Kharif* rice at 4-6 cm depth in optimum moisture or else give light irrigation before dibbling depending on the soil type.
- Seed treatment: 1.4 ml imidacloprid + 2 g carbendazim (Bavistin) per kg seed or thiomethaxam @ 3 g/kg seed.
- Adopt fertilizer management and need based plant protection measures like normal *Rabi* maize.
- Dibble the seed after harvesting *Kharif* rice at 3-4 seeds at 4-6 cm depth in optimum moisture or else give light irrigation before dibbling depending on the soil type.
- Practice line sowing by adopting a spacing of 60 x 20 cm / 45 X 10-15 cm (1,80,000 pls/ha)
- Spray Gramoxone / Paraquat @ 1.0 lit/acre (5 ml /l) to prevent the regrowth of rice stubbles. Spray Atrazine 800 g - 1.2 kg/acre (4 g/l) immediately after sowing or next day to prevent broad leaved weeds.
- Ensure proper moisture at the time of spraying herbicide.
- Provide 5-6 irrigations based on the soil type and climatic conditions.

MILLETS

JOWAR (*Sorghum bicolor*)

Varieties

Kharif

Varieties: PSV-1, Palem-2, CSV-10, CSV-11, CSV-13, CSV-15 and Srisaila (PSV 56)

Normal rainfall areas of Coastal districts: CSV 10, CSV 11, CSV 13, CSV 15, PSV 1, Palem-2, Srisaila (PSV 56), CSV 17, CSV 20, CSV 23

Hybrids: CSH-10, CSH-11, CSH 13, CSH-14, CSH-16, CSH- 18, CSH-21, PSH 1, CSH 23, CSH 25, CSH30

Normal rainfall areas of Coastal districts: CSH 10, CSH 11, CSH 16, CSH 18. CSH 21

Rabi

Varieties: NTJ-2, NTJ-4, NTJ-5, CSV 216R, CSV 14R, M35-1, Kinnera

Normal rabi areas of Coastal districts: CSV 14R, CSV 216R, M35-1, NTJ2, N14, N15, CSV18, CSV 22

Hybrids: CSH 13R, CSH-15 R, CSH-16

Normal rabi areas of Coastal districts: CSH 15R, CSH 19R, CSH 31R

Sweet stalk sorghum: SSV84, CSV19SS, CSH 20SS

Rice fallows: CSH-13 R, CSH 14, CSH15 R, CSH-16, CSH 31R

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothening before sowing helps in better insitu moisture conservation

Seed treatment: Treat the seed with Thiometaxam @ 3 g/kg seed and Thiram or Captan @ 3 g/kg seed.

Sowing time:

- Kharif: 1st week of June to 2nd week of July
- Rabi: 2nd fortnight of September to October end
- Maghi: September
- Rabi: October, Late Rabi: November
- Summer: January

Seed rate and Spacing: 3 - 4 kg/acre, 45 x 12-15 cm

Fertilizer doses and time of application: FYM: 4 t/acre,

Light soils with low rainfall Basal: 12N + 16P + 12K kg/acre, Top: (30-40 days crop): 12 N kg/acre,

Fertile soils with assured rainfall Basal: 16N + 24P + 16K kg/acre, Top: (30-40 days crop): 16 N kg/acre

Weed control (name of chemical and mechanical): Two manual weedings along with two intercultural operations with danti are effective. Pre emergence application of Atrazine @ 4 g/litre with in 48 hrs of sowing coupled with one manual weeding and one intercultural operation is also economical.

Witch weed: Pre emergence spray of Atrazine @ 4 g/L, spray Ammonium sulphate @ 50 g/l or Urea 200 g/l on striga plants, destroy the parasites before flowering.

Intercropping: 2:1 or 3:3 Sorghum: cowpea / redgram / sunflower / chickpea

Major disease and pest control

Pests

Shoot fly

- In late sown crop, use high seed rate of 4-6 kg/acre and thinning of affected and extra plants at 4 weeks after sowing.
- Seed treatment with imidacloprid @ 5 ml/kg of seed/ Carbosulfan 50 SP @ 100g/kg seed.
- In heavy infestation areas, soil application of Carbofuran 3G granules @ 8 kg/acre (2g/m) in furrows, at the time of sowing.
- Damage can be minimized by spraying the seedlings at 7, 14 and 21 DAS with Thiodicarb @ 1.5g/l or Lambdacyhalothrin @ 2ml/l.

Stem borer

- Whorl application of Carbofuran 3G @ 8 kg/acre at 25 and 35 d.a.e.

Corn leaf Aphid: Spraying of Methyl demeton or Dimethoate @ 2ml/l

Shoot bug and Ear head bug

- Application of Malathion 5D @ 8 kg/acre at pre bloom and again at milk stages.
- Spray malathion 50 EC @ 2 ml/l.

Panicle worm

- Application of Malathion 5D @ 8 kg/acre
- Spraying of Monochrotophos @ 1.6ml/L

Mite: Spraying Dicofol 3 ml/litre or Monochrotophos @ 1.6 ml/L ETL Infestation exceeding 25%

Sorghum midge

- Enmass sowing with varieties of uniform maturity will escapes the pest incidence.
- Application of Malathion 5 D @ 20kg/ha at 90% ear head emergence stage.

Fall Army Worm: Same as maize

Diseases

Grain molds

- Spray Propiconazole (Tilt) @ 0.5 ml/l twice from 50% flowering to 10-15 days later.
- Timely harvest and drying immediately after physiological maturity.
- Seed treatment with thiram @ 0.3% will prevent seedling infection.

Ergot / sugary disease/ honey dew disease

- Mechanical removal of sclerotia from seeds by washing in 2% (20 g/l) salt solution followed by plain water rinsing before sowing.
- Seed treatment with captan @ 4g/kg seed
- Spraying with benlate @ 1g/l or Propiconazole @ 0.5ml/l or mancozeb @ 2 g/l at 10% flowering followed by another spray at 50% flowering.

Smuts

Head smut/ Loose Kernel Smut / Covered kernel smut

- Seed dressing with Thiram or captan @ 3g/kg seed.
- Use disease free seed and practice crop rotation.

Downy mildew

- Seed treatment with Metalaxyl (apron 35 SD) @ 4g/kg seed.
- Spray Mancozeb @ 3g/l / Metalaxy (Ridomil MZ) @ 0.2%.

Charcoal rot

- Recommended dose of fertilizer and low plant density reduces the disease
- Avoid moisture stress at flowering.

Leaf blight or stripe

- Seed treatment with thiram or captan @ 4 g/kg seed.
- Spray mancozeb @ 2.5 g/l at 40 DAS and at fortnightly interval.

Rust

- Dusting of sulphur @ 10 kg/acre.
- Spray mancozeb @ 2.5 g/l thrice commencing from one month old crop at 10day interval.

Anthracnose

- Seed treatment with captan or thiram @ 3 g/kg seed.
- Spray mancozeb @ 2.5 g/l or carbendazim @ 1 g/l.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at sowing, 20-25 days after sowing, ear head emergence / flowering and grain filling stages.

Rice-fallow Sorghum under zero tillage

- CSH14, 16, Haritha, Kaveri 6363, Mahyco 51, Mahalaxmi 296 etc.
- Sowing time is November to January in Coastal Andhra Pradesh.
- No preparatory tillage is done
- Seed rate: 3 kg/ac.
- Treat the seed with 1.4 ml imidacloprid + 2 g carbendazim (bavistin) or 3g thiomethaxam per one kg seed.
- Dibble 3-4 seeds after harvesting *Kharif* rice at 4-6 cm depth in optimum moisture or else give light irrigation before dibbling depending on the soil type.
- Practice line sowing by adopting a spacing of 45 X 10-15 cm (72.00.000 pls/ac).
- Fertilizers: As rabi sorghum.
- Spray Gramoxone / Paraquat @ 1.0 lit/acre (5 ml /l) to prevent the regrowth of rice stubbles.
- Spray Atrazine 800 g - 1.2 kg/acre (4 g/l) immediately after sowing or next day to prevent broad leaved weeds.
- Ensure proper moisture at the time of spraying herbicide.
- Adopt fertilizer management and need based plant protection measures like normal *Rabi* maize.
- Provide 5-6 irrigations based on the soil type and climatic conditions.

BAJRA (*Pennisetum glaucum*)

Varieties along with recommended area

Open pollinated varieties (Composites & synthetics): ICMV 221, ICTP 8203, Dhanshakti and ABV-04.

Hybrids: HHB 67 and ICMH 356

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better insitu moisture conservation.

Seed treatment: Soak the seed in 2% (20 g /lit) salt solution for 10 minutes to remove ergot infected seed. Treat the seed with Thiram or Captan @ 3 g/kg seed or metalaxyl (apron) 35 SD 6 g/kg seed.

Sowing time

Kharif: June to 15th July

Rabi: September- October

Summer: January 15 – February end

Seed rate and Spacing: 1.6 kg/acre, 45 x 12 - 15 cm, Remove excess plants at 15-20 days age of the crop

Fertilizer doses and time of application: FYM: 4 t/acre

Irrigated conditions: Basal: 16 N + 16 P + 12 K kg/acre, Top (30-35 days crop): 16 N kg/acre

Rain fed conditions: Basal: 12 N + 12 P + 8 K kg/acre, Top (30-35 days crop): 12 N kg/acre

Weed control (name of chemical and mechanical)

- Two manual weedings along with one or two intercultural operations with danti is effective.
- Pre emergence application of weedicide Atrazine @ 4 g/lit with in 48 hrs of sowing coupled with one manual weeding and one intercultural operation is also economical.

Intercropping: 2:1 Bajra: redgram/ greengram / sunflower / soybean / groundnut

Major disease and pest control

Pests

White grub

- Apply Carbofuran granules @ 8kg/acre in seed furrows at the time of sowing.
- Mixing of Carbofuran 3G @ 5 Kg/acre with bajra seed and application in seed furrows at the time of sowing is effective.
- Spray host trees with Chlorpyrifos 0.2% with onset of monsoon within 2-3 days after receipt of first showers.

Shoot fly

- Increase the seed rate to 4-10 kg if sown late and remove infested seedlings.
- Seed treatment with imidacloprid 70% WS @ 10g/kg seed.
- Application of Carbofuran 3G at 8 kg/acre in seed furrows (2g/m row) at sowing.
- Minimize damage by spraying Thiodicarb @ 1 g/l or Lamdacyhalothrin @ 2 ml/l at 7 and 14 days after emergence.

Grey weevil and other leaf feeding and ear head pests

- Dust Fenvalerate 0.4% or Quinolphos 1.5% Carbaryl 10D @ 10 kg/acre

Pink boll worm (*Sesamia inferens*) & Stem borer (*Chilo partellus*):

- Spray metasystox 25 EC @ 2ml/l.
- Apply Carbofuran @4 kg/ac at 35-40 DAS.

- Release Trichogramma chilonis cards @ 1/ac twice.

Helicoverpa: Spraying of Malathion (2ml/l) effectively controls the pest.

Fall Army Worm: Same as maize

Diseases

Downy mildew

- Seed treatment with Metalaxyl (Apron 35SD) @ 6g/kg seed.
- Foliar spray of Ridomil 25WP @ 1 g/l after 21 DAS if infection exceeds 2-5%
- Uproot and burn the infected plants.
- Avoid monoculture of particular cultivar.

Ergot

- Dip seeds in 20% salt solution, stir and remove floating seeds and sclerotia. Seeds remaining at the bottom should be shade dried and sown.
- Treat seed with thiram or captan @ 3 g/kg seed.
- Plough the field soon after harvest to bury the ergot inoculum deep.
- Spraying Ziram @ 2g/l or mancozeb @ 2.5 g/l or carbendazime @ 1 g/l at boot leaf and flowering stages.

Smut

- Collection and destruction of infected ears.
- Seed treatment with Thiram or Captan @ 3g/kg seed.
- Spray with Captafol (2ppm) followed by Zineb (2ppm) at boot leaf and panicle emergence stage.

Rust: Spray Mancozeb 2g/l.

Grain mold

- Timely harvest and drying immediately after physiological maturity.
- Spray Propiconazole 0.5 ml/L twice during grain filling stage when the crop is caught in rains.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at sowing, tillering, ear head emergence / flowering and grain filling stages.

Harvesting: In general, the maturity duration is 80-85 days.

Expected yield of the variety: In general, the varieties give grain yield of 8 – 10 q/acre and hybrids will give a grain yield of 12-14 q/acre.

RAGI (*Eleusine coracana*)

Varieties along with recommended are

Kharif

Short duration (80-90 days): Maruthi and Champavathi

Medium duration (100-115 days): Saptagiri, Bharathi, Godavari, Srichaitanya, Vakula, Tirumala, Vegavathi, Suwarnamukhi, Gouthami and Indravathi

Rabi and Summer

Short duration (80-90 days): Maruthi and Champavathi

Medium duration (100-115 days): Saptagiri, Bharathi, Godavari, Vakula and Hima (White ragi variety suitable for growing in Rabi season), Tirumala, Vegavathi, Suwarnamukhi, Gouthami and Indravathi.

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better *in situ* moisture conservation.

Seed treatment: Treat the seed with Carbendazim @ 2 g or Mancozeb @ 3 g/kg seed or Tricyclozole 75% WP @ 2 g/kg seed.

Sowing time: Kharif: July- August, Rabi: November – December, Summer: January – February.

Seed rate and Spacing

Seed rate

- 2.5 kg/acre (Raise nursery in 5 cents)
- 3-4 kg/acre for direct sowing
- Transplanting short duration varieties with 21 days old seedlings (2,66,000 plants/acre) and late duration varieties with 30 days old seedlings (1,33,000 plants/acre).

Spacing

- 15 cm X 10 cm for early varieties
- 15-20 cm x 15 cm for late varieties

Fertilizer doses and time of application

- FYM : 4 t/acre
- Basal : 12N + 12P + 8K kg/acre
- Top (35-40 days crop): 12N kg/acre
- Nursery: 640g N + 640g P + 480g K for 5 cents

Weed control (name of chemical and mechanical): Line sown crop - 2-3 inter cultivations + one hand weeding. Broad cast crop- two hand weedings. Pre emergence – Oxdadiargyl 80 WP @ 200 g a.i./ha. Spray anilophos 30% @ 1.75 l/ha one week after transplantation.

Spray Ethoxysulfuron @ 0.5ml/l on broad leaved weeds 25-30 days after sowing or transplanting. In assured rainfall areas, Spray pendimethalin 30 % (stomp) @ 3 ml/lit as pre-emergence application within 48 h after sowing. 2, 4-D Sodium salt @ 2 g/lit as post emergence application at 20-25 days after planting for removal of broad-leaved weeds.

Intercropping: 8:2 Ragi: redgram / field bean, 4:1 Ragi: soybean

Major disease and pest control

Army worms and Cut worms

- Dust Malathion 5% or Phosalone 5% or Quinolphos 1.5% @ 8-10 kg/acre.
- Spray Chlorpyrifos @ 2.5 ml/l or Quinolphos 2 ml/l

Pink borer: The pest bores stem and kills growing crown. If it infects panicles the panicles turn white.

- Burn infected plants and spray Metasystox 25 EC 2 ml/l.

Leaf aphid: Spray Dimethoate 2 ml/l

Stem borers: Spray Dimethoate 2 ml/l or Monocrotophos 1.6 ml/l

Ear head caterpillars: Dust Malathion 5% or Phosalone 5% or Quinolphos 1.5% @ 8-10 kg/acre. Spray chlorpyrifos @ 2ml/l

Termites: 2% MP dust @ 8kg/ac or lindane 10 kg/ac, destroy mounds with 5ml/l Chloropyrifos or 1 ml/l Imidacloprid 70% WS (10-12 l solution per mound).

Diseases

Blast

- Treat the seed with Carbendazim @ 2g / kg seed or Tricyclozole 75% WP @ 2 g/kg seed.
- Spray the nursery with Carbendazim (0.05 %) @ 1 g/lit, or Kitazin (0.1 %) @ 3 ml/lit or Ediphenphos (0.1 %) @ 1 ml/lit or Tricyclozole 75% WP @ 0.5 g/l.
- Spray any of the above fungicides at 50 % flowering and repeat 10 days later to control neck finger blast.
- Dip seedlings in blitox/Mancozeb @ 3g/L

Brown leaf spot

- Damage could be severe if the crop is subjected to drought or nutrition deficiency. The disease can be effectively managed by proper nutrition and water management.
- Need based spray of Mancozeb or Saaf 2.5 g/l

Leaf blight

- Seed treatment with captan or thiram @ 3g/l
- Spray mancozeb @ 2.5 g/l

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at 3 days after transplanting, tillering, ear head emergence / flowering and grain filling stages.

Harvesting: For short duration varieties: 80-90 days, for medium duration varieties: 110 – 115 days, for long duration varieties: 120-130 days.

Expected yield of the variety: In general, the varieties give grain yield of 10 – 14 q/acre.

KORRA (*Setaria italica*)

Varieties along with recommended area: Prasad, Krishnadevaraya, Narasimharaya, Srilakshmi, Suryanandi, SiA 3085, SiA 3156, Renadu and Garuda.

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better insitu moisture conservation.

Seed treatment: Treat the seed with Carbendazim @ 2g / kg seed.

Sowing time: Kharif: July- August, Rabi: December – January and Summer: January

Seed rate and Spacing: 2 kg/acre for line sowing, 4 kg/acre for broad casting and Line sowing: 25 x 10 cm.

Fertilizer doses and time of application: FYM: 4 t/acre, Basal: 8N + 8P + 0K kg/acre and Top (30 days crop): 8 N kg/acre.

Weed control (name of chemical and mechanical): In line sown crop, 2-3 inter cultivations with one hand weeding. In broad cast crop, two hand weedings.

Mangement

- Pre emergence spray with isoproturon @ 400 g/acre or butachlor 50% @ 750 ml/acre at 1-2 days after sowing.
- Spray atrazine 50% @ 1.2 kg/ha as pre-emergence 1 or 2 days after sowing. Spray metsulfuron methyl 10% + chlorimuron ethyl 10% @ 15 g/ha at 20-25 DAS.

Intercropping

- **Intercropping:** 2:1 korra: groundnut; 5:1 Korra: soybean / cotton/ redgram
- **Relay cropping:** Korra sown at 45 cm and Jowar as relay crop
- **Sequence cropping:** Korra with mustard / green gram/ redgram/ sunflower/ chickpea

Major disease and pest control

Pests

Army worms, cut worms and Leaf scraping beetles: Need based dust application of Malathion 5% @ 8-10 kg/acre. Spray chlorpyrifos 2.5 ml/l or quinolphos 2 ml/l or Metacystox 25 EC @ 2 ml/l or Monocrotophos @ 1.6 ml/l.

Diseases

Blast, Brown spot and Rust: If these diseases appear at the early stages of the crop, spray Mancozeb 2.5 g/l or Tricyclozole 75% WP 0.5 g/l.

Grain smut: Seed treatment with Carbendazim @ 2 g/ kg seed.

Downy mildew / Green ear: Seed treatment with Ridomil MZ @ 2 g/l or metalaxyl @ 1 g/kg seed. Roguing out and destroying the affected plants. Spray 1g/l metalaxyl or 2.5 g/l mancozeb.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given after sowing, tillering, ear head emergence / flowering and grain filling stages.

Harvesting: For early duration varieties: 70-75 days, for medium duration varieties: 80-85 days.

Expected yield of the variety: In general, these varieties give grain yield of 10 - 12 q/acre.

LITTLE MILLET OR SAMA (*Panicum sumatrense*)

Varieties along with recommended area

Kharif: OLM 20, OLM 36, OLM 203, OLM 208, OLM 217, BL 6M DHLM 36-3 and Co 4. These varieties can be grown in Andhra Pradesh

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better *in situ* moisture conservation.

Seed treatment: Treat the seed with Carbendazim @ 2g / kg seed.

Sowing time: *Kharif:* June – July

Seed rate and Spacing: 3-4 kg/acre, 25 cm x 10 cm.

Fertilizer doses and time of application: FYM: 2 t/acre, 8:8:8 NPK kg/acre – Basal.

Weed control (name of chemical and mechanical)

- In line sown crops- 2-3 inter cultivations with one hand weeding.
- In broadcasted crop- Two hand weedings.
- Pre emergence spray with Isoproturon @ 400 g/acre at 1-2 days after sowing.

Intercropping: 2:1 Little millet: Blackgram/Redgram/Sesamum/Soybean

Major disease and pest control

Pests

Shoot fly: Early sowing with onset of monsoon; Reduce Nitrogen by 50 % and apply FYM or bio fertilizers.

Diseases

Grain smut: Seed treatment with carbendazim @ 2 g/kg seed.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at tillering, ear head emergence / flowering and grain filling stages.

Harvesting: OLM 20 & Co 4: 75 – 80 days, BL6, DHLM 36-3 & OLM 36: 95 – 100 days
OLM 208, OLM 217, OLM 203: 100 – 110 days.

Expected yield of the variety: In general, these varieties give grain yield of 4 - 6 q/acre.

VARIGA (*Panicum miliaceum*)

Varieties: Co – 4, TNAU 143, TNAU 151, TNAU 164, TNAU 202, GPUP 8, GPUP 21 and PR 18.

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better *in situ* moisture conservation.

Sowing time: Kharif: June – July, Rabi: October – November months

Seed rate and Spacing: 3.2 – 4.8 kg/acre, 25 cm x 10 cm

Fertilizer doses and time of application: FYM: 2 t/acre, 8:8:8 NPK kg/acre – Basal

Weed control (name of chemical and mechanical):

- In line sown crops- 2-3 intercultivations with one hand weeding.
- In broadcasted crop- Two hand weedings.
- Pre emergence spray with Isoproturon @ 400 g/acre at 1-2 days after sowing.

Major disease and pest control

Shoot fly: Early sowing with the onset of monsoon is an effective and cheapest method of control.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at tillering, ear head emergence / flowering and grain filling stages.

Harvesting: 70 – 75 days after sowing

Expected yield: 6 – 8 q/acre

Name of the crop: Aarikalu

Varieties: TNAU 86, JK 13, JK 48, JK 65, JK 98 and DPS 9-1.

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better *in situ* moisture conservation.

Seed treatment: Carbendazim @ 2g / kg seed, Chlorothalonil or Mancozeb @ 2g/kg seed against head smut.

Sowing time: Kharif: June – July and Rabi: October – November months

Seed rate and Spacing: 3 –4 kg/acre, 25 cm x 10 cm

Fertilizer doses and time of application: FYM: 2 t/acre, 8:8:8 NPK kg/acre – Basal

Weed control (name of chemical and mechanical)

- In line sown crops- 2-3 intercultivations with one hand weeding.
- In broadcasted crop- Two hand weedings.
- Pre emergence spray with Isoproturon @ 400 g/acre at 1-2 days after sowing.

Major disease and pest control

Pests

Shoot fly: Early sowing with the onset of monsoon is an effective and cheapest method of control.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at tillering, ear head emergence / flowering and grain filling stages.

Harvesting: 95 – 100 days after sowing.

Expected yield: 10 – 12 q/acre

OODALU (*Echinochloa frumentacea*)

Varieties: Sushruta, VL Madira, Co 2 and DHBM 93-3.

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better *in situ* moisture conservation.

Seed treatment: Treat the seed with Carbendazim @ 2g / kg seed.

Sowing time: Kharif: June – July, Rabi: October – November months

Seed rate and Spacing: 3– 4 kg/acre, 25 cm x 10 cm

Fertilizer doses and time of application: FYM: 2 t/acre, 8:8:8 NPK kg/acre – Basal

Weed control (name of chemical and mechanical):

- In line sown crops- 2-3 intercultivations with one hand weeding.
- In broadcasted crop- Two hand weedings.
- Pre emergence spray with Isoproturon @ 400 g/acre at 1-2 days after sowing.

Major disease and pest control

Pests

Shoot fly: Early sowing with the onset of monsoon is an effective and cheapest method of control.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at tillering, ear head emergence / flowering and grain filling stages.

Harvesting: 80 – 95 days after sowing

Expected yield: 8 – 10 q/acre

ANDUKORRA

Varieties: GPUBT 6, BT 10, BT 7, TNBR 001 and HMRAK 2

Land preparation: One deep ploughing with mould board plough followed by ploughing with wooden plough twice in summer season. Before sowing, secondary tillage with cultivator to prepare smooth seed bed. Minor land smoothing before sowing helps in better *in situ* moisture conservation.

Seed treatment: Treat the seed with Carbendazim @ 2g / kg seed

Sowing time: Kharif: June – July, Rabi: October – November months

Seed rate and Spacing: Line sowing: 2 kg/acre, Broadcasting: 4 – 5 kg/acre, 45 cm x 15 cm.

Fertilizer doses and time of application: FYM: 2 t/acre, 8:8:8 NPK kg/acre – Basal

Weed control (name of chemical and mechanical):

- In line sown crops- 2-3 intercultivations with one hand weeding.
- In broadcasted crop- Two hand weedings.
- Pre emergence spray with Isoproturon @ 400 g/acre at 1-2 days after sowing.

Major disease and pest control

PESTS:

Shoot fly: Early sowing with the onset of monsoon is an effective and cheapest method of control.

Irrigation schedule along with critical stages: In irrigated crop, irrigation should be given at tillering, ear head emergence / flowering and grain filling stages.

Harvesting: 60 – 70 days after sowing

Expected yield: Grain: 7 – 8 q/acre, Fodder: 16 – 20 qS/acre.

PULSES

GREENGRAM

Varieties

Kharif: LGG 407, LGG 460, TM 96-2, IPM 2-14 and WGG 42.

Rabi-Uplands: LGG 460, LGG 407, TM 96-2, WGG 42, IPM 2-14.

Rice fallows: LGG 460, TM 96-2, LGG 410, LGG 407, IPM 2-14.

Summer: LGG 460, LGG 407, WGG 42, IPM 2-14.

BLACKGRAM

Kharif: GBG 1, TBG 104, LBG 787, LBG 752, LBG 20, T 9, PU 31.

Rabi-Uplands: GBG 1, TBG 104, LBG 787, LBG 752, LBG 685, LBG 645, LBG 709, LBG 20, T 9, PU 31.

Ricefallows: LBG 648, LBG 645, LBG 685, LBG 709, LBG 752, LBG 787, TBG 104, GBG 1.

Summer: GBG 1, TBG 104, LBG 752, PU 31.

Soils : All types of soils with good drainage facilities. Saline soils are not suitable.

Land preparation: Land should be prepared to fine tilth with two ploughings followed by harrowing.

Sowing time

Crop	Kharif	Rabi uplands	Rice fallows	Summer
Greengram & Blackgram	June 15 - July 15	First fortnight of October	2nd fortnight of November to first fortnight of December	Mid February to mid of March (uplands) March 15 th to March ending. (Rice fallows)

Seed rate

Crop	Kharif	Rabi uplands	Rice fallows	Summer
Greengram	15-16 kg/ha	15-16 kg/ha	30-32 kg/ha	16-18 kg/ha
Blackgram	18-20 kg/ha	18 -20 kg/ha	40-45 kg/ha	20 kg/ha

Seed treatment: Treat the seed with captan/ thiram / mancozeb / carbendazim 2.5 g per kg seed and imidacloprid 600 FS @ 5 ml or thiamethoxam 70 WS @ 5g /kg seed 24-48 hours before sowing to protect the crop from sucking pests and diseases upto 15-20 days after sowing. First treat the seed with fungicide and allow to dry for 30 – 60 min, then treat the seed with insecticide and dry them in shade. Later treat the seed with *rhizobium* 20 g/kg seed before one hour of sowing.

Spacing: 30 x 10 cm

Manures and fertilizers: 20 N + 50 P₂O₅ kg/ha as basal

Intercultivation : Twice at 20 and 30 DAS

Weed Control : Spray pendimethalin at 2.5 to 3.5 lt/ha immediately after sowing or the next day to check the weed growth for the first 20-25 days.

Post-emergence application of (if needed) imazethapyr 500 ml/ha at 20-25 days after sowing will control all weed flora if only grassy weeds are problem spray quizalofop ethyl 1.0 lt/ha.

Irrigation: Usually grown as rainfed. Irrigate twice if water is available at 30 and 50 DAS to get higher yields.

Pest management

Stemfly: Seed treatment as above. Spray acephate 1.0 g or monocrotophos 1.6 ml or dimethoate 2.0 ml per litre twice at weekly intervals from 10 days after sowing

Flea beetles: Seed treatment as above. Spray monocrotophos 1.6 ml or acephate 1.0 g or chlorpyrifos 2.5 ml per litre if the incidence is severe.

Thrips: Spray either monocrotophos 1.6 ml or acephate 1.0 g or fipronil 1.5 ml or dimethoate 2.0 ml or spinosad 0.3 ml or acetamiprid 0.2 g or thiamethoxam 0.2 g per litre.

Whitefly: Foliar application of 5 % NSKE at 20 DAS as prophylactic spray against whitefly that transmits YMV. Spray monocrotophos 1.6 ml or acetamiprid 0.2 g or diafenthiuron 50 WP @ 1.25 g per litre

Aphids: Spray either acephate 1.0 g or monocrotophos 1.6 ml or imidacloprid 0.3 ml or acetamiprid 0.2 g per litre.

Maruca Pod borer: Monitor the occurrence of adult moths at flower bud initiation stage of blackgram/greengram (i.e at 30-35 DAS).

- Application of 5% NSKE or neem oil @ 5 ml/lit should be taken up before flower bud initiation or at 35 DAS to avoid egg laying by Maruca adults.
- Spray either thiodicarb 75 WP @ 1.0 g/lit or profenophos 50 EC @ 2.0 ml/lit which has ovicidal action at the time of flower initiation.
- First spray with ovicides should be given one week before flower initiation as and when the adult population is noticed in the crop.
- Spray acephate 1.0 g or chlorpyrifos 2.5 ml or quinalphos 2.0 ml or thiodicarb 1.0 g per litre at the time of flowering stage.
- In case of severe incidence spray either novaluron 1.0 ml or spinosad 0.3 ml or emamectin benzoate 0.4 g or chlorantraniliprole 0.3 ml or flubendiamide @ 0.2 ml/lit
- Use 500 liters of spray fluid per hectare with hand compression sprayer
- Use 150-170 liters of spray fluid per hectare and increase the insecticide dose three times while using power or Taiwan sprayer,
- Repeat the spray twice at 15 days interval by changing the insecticide depending on the intensity of the pest.
- Do not spray the crop during early morning hours until the dew on leaf surface dries off

Tobacco caterpillar

Adoption of IPM practices such as

- Erection of Pheromone traps 10/hectare
- Growing of castor as trap crop to monitor egg laying and hatching,
- Collection and destruction of skeletonised leaves along with first instar larvae
- Spraying of SNPV 500 LE/ha.
- Spray either chlorpyrifos 2.5 ml or acephate 1 g or quinalphos 2 ml per litre against early instars.
- Apply poison bait containing rice bran, jaggery and insecticide (chlorpyrifos / monocrotophos) 10:1:1 ratio against grown up caterpillars in the evening hours.

Disease management

Collar rot: Seed treatment with captan/ thiram / mancozeb / carbendazim 2.5 g per kg seed

Anthracnose, Cercospora leaf spot: Seed treatment as above. Spray carbendazim 0.1% or mancozeb 0.25% or hexaconazole 0.2% by alternating the chemicals twice at 10 days interval.

Powdery mildew: Spray carbendazim 0.1% or thiophanate methyl 0.1% or hexaconazole 0.2% or propiconazole 0.1% twice at 10 days interval soon after noticing the disease.

Plant Protection Schedule in rice fallows:

Diseases: Corynespora leaf spot, Anthracnose, Cercospora leaf spot, Powdery mildew

30-35 DAS: Hexaconazole 2 ml/lit

50-55 DAS: Propiconazole 1 ml/lit

Integrated management of viral diseases in blackgram and greengram

- Cultivate YMV resistant/ tolerant varieties
- Mungbean : LGG 460, LGG 407, WGG 42, IPM 2-14
- Urdbean : GBG 1, TBG 104, LBG 752, LBG 787, PU 31.
- Treat the seed with imidacloprid 600 FS @ 5 ml or thiamethoxam 70WS @ 5 g which is compulsory to escape from viral diseases.
- Remove and destroy the MYMV and other viral diseased or infected weeds in the fields/ on the field bunds/ around the fields.
- Sow four rows of maize or jowar or bajra around the field as a guard crop to prevent the movement of vector population from neighboring fields.
- Rogue out and destroy the viral infected plants when observed in the field
- Erect yellow sticky traps for whiteflies and blue sticky traps for thrips 20/acre for each pest to monitor the vector population.
- Spray 1500 ppm neem oil 5.0 ml/l or NSKE 5% at 15 days interval to destroy the eggs and nymphal population of the vector
- Spray monocrotophos 1.6 ml or acephate 1.0 g or profenophos 2.0 ml or acetamiprid 0.2 g or thiamethoxam 0.2 g per litre at 10-15 days interval against whiteflies.
- Spray monocrotophos 1.6 ml or acephate 1.0 g or thiamethoxam 0.2g or fipronil 1.5 ml or spinosad 0.3 ml per litre against thrips.
- Spray acephate 1g or imidacloprid 0.4 ml or acetamiprid 0.2g or thiamethoxam 0.2g or monocrotophos 1.6 ml or dimethoate 2 ml per litre against aphids.

REDGRAM

Varieties

Medium duration: LRG 105, TRG 59, LRG 133-33, LRG 52, LRG 41, LRG 38, TRG 22, LRG 30, ICP 8863, ICPL 332, ICPL 87119, ICPL 85063

Short duration: ICPL 84031 (Durga), ICPL 85010 and CORG 9701 (CO7)

Wilt resistant varieties: LRG 105, TRG 59, LRG 133-33, ICP 8863 and ICPL 87119.

SMD resistant varieties: LRG 105, TRG 59, ICPL 87119, BSMR 736 and BSMR 853.

Soils/areas: All types of soils with good drainage. Saline soils are not suitable.

Land preparation: Land should be prepared to fine tilth by ploughing 2 to 3 times followed by harrowing.

Seed rate: Medium duration varieties Kharif: 5-10 kg/ha, Rabi: 12-15 kg/ha

Spacing: Medium duration varieties: 150/ 240 x 20 cm (depending on soil type)

Short duration varieties: 90 x 20 cm (black soils) or 60 x 20 cm (light soils)

Rabi : 45-60 x 10 cm rainfed: 90 x 10 cm under ID conditions

Sowing/planting

Kharif: 15th June – August.

Rabi: September 20th to October 20th

Manures and fertilizers

Kharif: Apply 20 N + 50 P₂O₅ kg/ha as basal dose.

Rabi: 20 kg N and 50 kg P₂O₅/ha as basal+ 20 kg N as top dressing at 25 DAS

Intercultivation : Twice at 20 and 30 DAS

Weed Control : Spray pendimethalin at 2.5 to 3.5 lt/ha immediately after sowing or the next day to check the weed growth for the first 20-25 days (or) spraying of imazethapyr 750 ml at 25-30 DAS followed by intercultivation at 50-55 DAS.

INTERGRATED PEST MANAGEMENT OF *HELICOVERPA* ON REDGRAM CULTURAL

- Summer ploughing
- Avoid mono-cropping
- Follow crop rotation
- Cultivate tolerant/recouping varieties (LRG 41, ICPL 332, LRG 38 and LRG 30)
- **Grow intercrops:** Maize, Sorghum, Soybean, Gingelly, Greengram, Blackgram, Dry paddy and Bajra.

II. MECHANICAL

- Monitor with Pheromone traps 10/ha
- Dislodge the larvae by shaking the plants

III. BIOLOGICAL

- Release Trichogramma twice at weekly intervals 65,000/ha
- Keep bird perches 50/ha up to flowering stage
- Spray NPV and B.T. (NPV 500 LE/ha or B.T. 1 kg/ha)

IV. PLANT PRODUCTS

- Use Neem oil 5 ml/l or NSKE 50 ml/l

V. SYNTHETIC PESTICIDES

- Follow need-based application
- Avoid cocktail mixtures.
- Aim the sprayings at early instars

- Chlorpyrifos 2.5 ml or quinolphos 2 ml or thiodicarb 1.0 g or novaluron 1.0 ml or acephate 1 g or spinosad 0.3 ml or chlorantraniliprole 0.3 ml or lamdacyhalothrin 1.0 ml or indoxacarb 1.0 ml or emamectin benzoate 0.4 g per litre alternatively during the flowering & pod formation stage.
- Ensure thorough coverage (500 l/ha)
- Discourage synthetic pyrethroids
- Avoid sub-lethal dosage
- Adopt community approach

Maruca Pod borer: Spray chlorpyrifos 2.5 ml at flowering stage, spinosad 0.3 ml or emamectin benzoate 0.4 g or chlorantraniliprole 0.3 ml or flubendiamide 0.2 ml or thiodicarb 1.0 g or novaluron 1.0 ml or lamdacyhalothrin 1.0 ml per litre in case of severe infestation.

Pod fly: Monocrotophos 1.6 ml or acephate 1 g or profenophos 2.0 ml or dimethote 2.0 ml or thiacloprid 0.7 ml per litre at the time of pod formation and development stages on need basis.

Mite: Prophylactic spray of wettable sulphur 3 g and dicofol 5 ml per litre at 45 & 60 DAS in SMD endemic areas for control of mite which are vector for SMD.

Disease management

Wilt: Grow resistant/tolerant varieties, LRG 133-33, LRG 105, TRG 59, LRG 52, ICPL 87119, ICP 8863, WRG 65, PRG 176.

Apply developed *Trichoderma viride* (80 kg well decomposed FYM + 20 kg neem cake + 2-3kg *Trichoderma viride* incubate for 25-30 days in shade) at the time of sowing. Crop rotation for 3 years.

Sterility mosaic virus: Grow resistant varieties, LRG 105, TRG 59, BSMR 853, BSMR 736 and ICPL 87119.

Macrophomina blight: Grow resistant varieties, MRG 66 and MRG 1004.

Post harvest technology: Properly dried produce can be stored in nylon bag, polythene lined gunny bag or compactly knitted gunny bag upto a period of 180 days.

BENGALGRAM

Varieties

Desi: Nandyal Gram 857 (NBeG 857) Nandyal Gram 452 (NBeG 452), Nandyal Gram 49 (NBeG 49), Dheera (NBeG 47), Nandyala Sanaga1 (NBeG 3), JG 11 and JAKI 9218.

Kabuli : Nandyala Gram 119 (NBeG 119), KAK 2, Vihar (Phule G 95311) and LBeG 7 (Lam sanaga),

Extra large seeded kabuli: MNK 1

Sowing: October to November

Soils : Medium to deep black soils

Seed rate: 85-90 kg/ha (desi); 100-110 kg/ha (kabuli);
130-150 kg/ha (Extra large seed kabuli)

Spacing : 30 x 10 cm

Fertilizers: 20 kg N, 50 kg P₂O₅, 40 kg S/ha as basal dose.

Intercultivation: Twice at 20 and 30 DAS

Weed Control: spray pendimethalin at 2.5 to 3.5 lt/ha immediately after sowing or the next day to check the weed growth for the first 20-25 days.

Irrigation: Rainfed, but one or two light irrigations at branching and pod formation stage will increase the yields by 15-20%.

Insect Pest control

Helicoverpa Pod borer

Adopt IPM practices against *Helicoverpa*

- Follow strip cropping of bengalgram with coriander (8:2 or 16:4)
- Sow four rows of sorghum all round the plot
- Transplant 50-100 marigold seedlings all round the plot
- Monitoring with pheromone traps @ 10/ha to target the pest at right stages.
- Use bird perches (50/ha)
- Use neem formulations for insect repelling (NSKE 5%) or neem oil 2.5 L/ha soon after the pest occurrence.
- Use bio-pesticides like Bt 1 kg/ha and NPV 500 LE/ha twice at an interval of 7-10 days in the evening hours.
- If necessary spray thiodicarb 1 g or spinosad 0.35 ml or rynaxypyr 0.2 ml or indoxacarb @ 1 ml or flubendiamide 0.25 ml per litre of water.

Spodoptera exigua

The incidence of *S.exigua* generally appears at early vegetative stage i.e upto 20-30 days after sowing. Larvae damage the lower leaves by scraping. In severe cases, foliage will drop down. Prophylactic spray of neem oil 3000 ppm 5 ml/ litre at 15 DAS and as curative measure spray either thiodicarb 1 g or emamectin benzoate 0.4g/l or rynaxypyr 0.2 ml per litre of water.

Diseases

Wilt

- Seed treatment with *Trichoderma* (8 g/kg) or captan or thiram 2.5 g/kg seed or Carbendazim 3 g/kg or Vitavax power 1.5g/kg or Tebuconazole 1.5 g/kg.
- Grow resistant varieties such as NBeG 3, N BeG 47, N BeG 49, NBeG 452, JG 11, and JAKI 9218.

- Apply developed *Trichoderma viride* (80 kg well decomposed FYM + 20 kg neem cake + 2-3kg *Trichoderma viride* incubate for 25-30 days in shade) at the time of sowing.
- Follow 3-4 year crop rotation with Sorghum, bajra, Setaria or maize.
- **Dry root rot**
- Timely sowing to avoid moisture stress and also high temperatures.
- Seed treatment with *Trichoderma* (8 g/kg) and / or captan or thiram @ 2.5 g or vitavax power 1.5 g or tebuconazole 1.5 g/kg seed
- Apply developed *Trichoderma viride* (80 kg well decomposed FYM + 20 kg neem cake + 2- 3kg *Trichoderma viride* incubate for 25-30 days in shade) at the time of sowing.
- Follow 3-4 year crop rotation with Sorghum, Bajra, Setaria or Maize.

Post Harvest Technology

Storage

Properly dried un-infested produce can be safely stored in triple layer bag, nylon bag, polythene lined gunny bag or compactly knitted gunny bag even upto a period of 180 days.

CRITICAL INTERVENTIONS

- Maintenance of optimum plant population (30-35 plants/sq.mt. and 44 plant per sq. mt in case of Dheera).
- Seed treatment with *Trichoderma* (8 g/kg) and / or captan or thiram 2.5 g/kg seed or carbendazim 3 g/kg or vitavax power 1.5g/kg or tebuconazole 1.5 g/kg seed.
- Pre emergence application of herbicides for suppression of weeds upto 20-30 days
- Timely pest and disease management
- Foliar nutrition of KNO₃ @ 5 g/l twice during dry spells and also in saline soils.
- Light irrigation at 30-35 days after sowing will increase the yield.

OILSEEDS
GROUNDNUT (*Arachis hypogaea*)

Varietal Management

- Use of high yielding and recommended crop varieties for the zone and season
- Use recommended seed rate and spacing to maintain optimum plant population.

Seed rate

Variety	Seed (kg/ac) <i>kharif</i>	Seed (kg/ac) <i>rabi</i>
Narayani, Kadiri-6, Dharani, Greesha, Rohini, Abhaya, ICGV 91114, Kadiri 9, Prasuna, ICGV 00350, Pragathi (TCGS894)	50-55	70-75
Kadiri Amaravathi, Kadiri Harithandra, Dheeraj, Nitya Haritha, Kadiri Chitravathi	60-65	80-85
Kadiri-7Bold, Kadiri-8 Bold	40-45	40-45
Bheema	65-70	80-85
Kadiri Lepakshi (K1812)	32-35	32-35

Spacing

Recommended Varieties	Season		
	Early <i>kharif</i>	<i>kharif</i>	<i>Rabi</i>
Narayani, Kadiri 6, Kadiri 9, Dharani, Kadiri Amaravathi, ICGV 91114, Kadiri Harithandra, Prasuna, Bheema, Dheeraj, Nitya Haritha, Pragathi (TCGS894)	-	30 x 10 cm	22.5 x 10cm
TAG 24, Greeshma and Rohini	22.5 x 10cm	-	22.5 x 10cm
Kadiri-7Bold, Kadiri-8Bold, Kadiri Lepakshi	30 x 15cm	30 x 15 cm	30 x 10 cm

- Follow seed treatment without fail for obtaining good germination and giving protection to the crop in the initial stages of crop growth as follows. Seed should be treated with Imidachloprid 600 FS @ 2 ml + 4ml of water / kg seed followed by Tebuconazole 2%DS @ 1g or Mancozeb @ 3 g / kg seed.
- *Trichoderma viride* seed treatment @ 8 g/kg seed for soil borne diseases

Take up sowings in time depending on the season.

Sowing Season

Region	Early <i>kharif</i> - Irrigated	<i>kharif</i> Rainfed and irrigated	<i>Rabi</i>
North coastal Andhra	March-April	June-July 2 nd FN of June	November to December
Rayalaseema	March-April	2 nd fortnight of June to up to 1 st week of August Best time -1 st FN of July	November to December. Best time-1 st FN of December

Nutrient Management

- Soil test based fertilizer application should be followed.
- Application of farm yard manure/ compost @ 4 tonnes /ac once in 2 – 3 seasons

- Application of 8N + 16 P₂O₅ + 20 K₂O kg/ac as basal for *kharif* crop. Phosphorus should be applied through single super phosphate.
- For *rabi* crop application of 8 N + 16 P₂O₅ + 20 K₂O kg/ac as basal and 4N kg/ac at flowering • Application of Gypsum @ 200 kg /ac at flowering stage by placement.
- Application of Zinc sulphate @ 20kg/ac once in 3 seasons.
- Wherever Iron deficiency is noticed on crop, spray 0.5 % ferrous sulphate along with 0.1 % citric acid two times with one week interval.
- Seed treatment with Rhizobium and soil application of Phosphorus Solubilising Bacteria (2 Kg/ac) will reduce the chemical fertilizers requirement.
- Rhizobium & PSB cultures can be obtained from ARS, Amaravathi, Guntur.
- Application of 4 kg Borax and 4 kg Ferrous sulphate per acre as basal to avoid deficiency
- Spraying multi micro nutrient mixture (Available commercial formulations) @ 1kg /ac in 200 litres of water at 30 and 60 DAS to avoid deficiency in the crop.

Weed management

- Crop must be kept weed free up to 45 days after sowing.
- Hand weeding should be done at 20 and 40 DAS.
- The crop should not be disturbed by either by weeding or intercultivation after 45 DAS.
- Chemical weed control may be adopted for effective weed management and cost minimization on weed control.
- Apply Fluchloralin 45 % EC @ 1.0 l/ac as pre plant incorporation i.e., spraying on soil before sowing of the crop and incorporation.
- Pre-emergence application of Pendimethalin 30 % EC @ 1.3 litres – 1.6 l/ac followed by one intercultivation or one hand weeding at 25 DAS will effectively control the weeds.
- Wherever pre-emergence herbicides could not be applied, post-emergence application of Imazethapyr 10 % EC @ 300 ml/ac at 20 DAS controls broad leaved weeds and grasses.
- For the control of only grassy weeds application of quizalofop Ethyl 5 % EC @ 400ml /ac at 20 DAS when the weeds are at 2-5 weed leaf stage of grassy weeds is recommended.
- Pendimethalin 30 % EC as pre emergence application followed by application of Imazethapyr 10 % EC @ 150 ml + Quizalofop Ethyl 5 % EC @ 200 ml per acre at 20 DAS or 2-3 leaf stage of weeds will effectively control weeds.

Irrigation management

- Groundnut crop requires on an average 400 to 450 mm.
- Good crop of groundnut requires 8 to 9 irrigations at 10 day interval starting from 25 DAS. Irrigation interval depends on soil type.
- After the crop is established, it is necessary to withhold irrigation for about 25 days to create stress which helps in synchronized flowering. • The last irrigation is to be at 15 days before harvesting.
- About 25-30 % irrigation water can be saved with sprinkler irrigation. • Critical stages for water management are flowering, peg penetration and pod development.
- Soil moisture conservation practices should be followed in rainfed crop.
- Apply 5 tonnes of groundnut shells per acre at 15-20 DAS as mulch to reduce evaporation losses and conserve soil moisture.
- To reduce transpiration losses from crop canopy, spray calcium sulphate solution (50 g/l).
- Spray urea solution (20 g/l) during dry spells in order to make the crop recover from stress.

Insect Pest Management

Follow IPM practices for the control of insect pests.

- Pre-monsoon deep ploughing (two/three times) during summer showers will expose the hibernating pupae to sunlight and predatory birds.
- Removal and destruction of alternate weed hosts which harbour the hairy caterpillars.
- Use trap crops around main crop eg. Cowpea. Avoid cowpea in endemic areas for bud & stem necrosis diseases. Collect the grown up larva by keeping Calotropis branches between the rows.
- Monitor the emergence of adult moths through light trap.
- Organize bonfires on community basis from 7.30 PM to 11.0 PM to attract the newly emerging moths for 3 or 4 succeeding days when good showers are received.
- Collect and destroy egg masses and early instars larvae.
- Dust Quinolphos or Carbaryl @ 10 kg /ac to control early instars of the caterpillar.
- To control grown up larvae, spray Dimethoate @ 2.0 ml or quinolophos 2.0 ml/l of water.
- Trap and kill the migrating larvae in deep cut straight trenches by dusting Methyl parathion 2 % in the trench around the field.
- If the pest level crosses the ETL, adopt chemical control using recommended chemicals

Disease Management

Follow integrated disease management practices especially for control of viral diseases especially PBNB and PSND.

- Growing of tolerant groundnut varieties namely Kadiri 9, Kadiri 7 bold, Kadiri Amaravathi, Kadiri Chitravathi and Kadiri Lepakshi (K1812)
- Seed treatment with Imidachloprid 600 FS @ 2 ml + 4 ml water /kg of seed.
- Weeds such as *Parthenium hysterophorus*, *Tridax procumbence*, *Ageratum conyzoides*, *Cleome viscosa*, *Commelina benghalensis*, *Vernonia cineraria*, *Achyranthus aspera*, *Acanthospermum hispidum* should be removed before flowering in and around the field
- Barrier crops namely bajra, maize and sorghum should be planted in 4-8 rows around the groundnut field. These will prevent thrips and wind borne weed pollen carrying virus
- Spraying of Monocrotophos 36 SL@ 320 ml or Dimethoate 30 EC@ 400 ml or Imidachloprid 17.8 SL@ 60 ml/ac in 200 liters of water at 25-30 days after sowing.
- Follow recommended control measures for the control of various diseases if the severity increases as follows
- Tikka leaf spot, Rust : Spraying of Mancozeb 75 WP @ 400 g + Carbendazim 50 WP@ 200 g /ac or Hexaconazole 5 SC @ 400 ml or Chlorothalonil 75 WP @ 400 g or Tebuconazole 25.9 EC @ 200 ml/ac in 200 litres of water at fortnightly intervals from first disease appearance.

Production Management

Tips for enhancing crop production

- Deep summer ploughing using sub-soiler
- Adoption of HYV
- Adoption of recommended seed rate
- Use small seed without shriveling of improved varieties
- Seed treatment
- Ensure optimum population
- Adopt recommended fertilizer dose

- Adoption of Ferti-cum- seed drill to ensure right placement of seed and fertilizer
- Apply Gypsum and SSP to provide calcium and Sulphur
- Avoid inter cultivation/weeding after 45 DAS.
- Adopt IPM & IDM Packages
- Practice crop rotation and intercropping
- Use mechanization for sowing, inter cultivation ,harvesting and stripping to reduce cost of cultivation

SESAMUM (*Sesamum indicum*)

Soils: Light textured to heavy soils with P^H 6.5 to 7.5 with good drainage facility are suitable. Acidic, alkaline and saline soils are not suitable.

Varieties recommended

S.No.	Variety	Duration (Days)	Kharif Yield (kg/acre)	Oil Content (%)	Seed Color	Special Characters
1.	Gouri	90	260	50	Dark Brown	-
2.	Madhavi	70 - 75	200	51	Light Brown	Can accommodate in crop sequence
3.	YLM-11 (Varaha)	80 - 85	300	52.5	Dark Brown	-
4.	YLM-17 (Gowtham)	75	350	52.5	Light Brown	Suitable for crop sequence. Moderately resistant to <i>Alternaria</i> leaf spot diseases.
5.	YLM-66 (Sarada)	80 - 85	450-500	51.5	Light Brown	Moderately resistant to <i>Macrophomina</i> root rot, <i>Alternaria</i> leaf spot & phyllody diseases

Season:

Early Kharif: May II FN

Rabi / Summer: Dec. 15 – January 31

Seed rate: 2.4 kg / acre

Seed treatment: Treat the seed with thiram /Captan/mancozeb @ 3 g/ kg seed against soil borne diseases. Against sucking pests, use Imidachloprid @ 5 ml or thiamethoxam @ 5 g per kg seed.

Sowing: Line sowing with a spacing of 30 cm between the rows and 15 cm between the plants is preferable. Mix the sand or broken rice in equal quantity to the seed will give good result, when broadcasting.

Manures and Fertilizers: Farm yard manure 4 tonnes, 16 kg nitrogen, 8 kg phosphorus and 8 kg potash supply fertilizers need to be applied per acre. The farm yard manure, entire phosphorus & potash and ½ of the nitrogen need to be applied as basal. The remaining ½ nitrogen need to be applied at flowering stage (30-35 DAS) followed by irrigation as top dressing.

Thinning: Thinning is to be done 15 days after sowing leaving single plant per hill

Weeding & Inter cultivation: Pendimethalin @ 4-5 ml/ l is to be applied within 48 hrs after sowing. Intercultivation with gorru is to be practiced at 20-25 DAS.

Plant protection:

Pests

- 1. Leaf webber cum capsule borer:** The caterpillars web the leaves and eat inside, later they become capsule borers and eat the seeds inside.
Control: Spray chlorpyrifos @ 2.5 ml or Monocrotophos @ 1.6 ml per litre of water.
- 2. Thrips:** Suck the sap from the leaves resulting in upward curling
Control: Monocrotophos @ 1.6 ml per litre of water.
- 3. Mites:** Suck the sap from the leaves resulting in downward curling
Control: Spray wettable sulphur @ 3g per litre of water

4. Bihar hairy cater pillar: Caterpillar eat the leaves

Control: Spray chlorpyrifos @ 2.5 ml. / litre of water.

Diseases

1. *Macrophomina* and *Rhizoctonia* root rot: Plants suddenly become wilt, dry and die.

Control:

- Remove the effected plants and destroy.
- Drench the soil with copper oxychloride @ 3 ml per litre of water at the base of the plants.

2. *Alternaria* Leaf spot: Brown spots appear on the leaves, later become dry. In severe cases it also effects the stem.

Control: Spray mancozeb @ 3 g or carbandazim @ 1 g per litre of water.

3. Phyllody: Flowers will become leafy like structures results no capsule formation.

Control: Remove the infected plants and destroy to avoid further spread.

Spray Methyl demeton or dimethoate @ 2 ml / litre of water

4. Powdery Mildew: Occurs mostly in *rabi* / summer season. White powdery like material appear on the leaves resulting in dropping leaves and decrease in seed weight

Control: Spray wettable sulphur @ 3g / litre of water.

Harvesting: When the crop becomes yellow and seeds turn brown in the capsules, harvest the crop and thresh. No chemical need to be sprayed on the heaps for the control of bugs etc., and if needs neem oil @ 5 ml / litre need to be sprayed.

Storage: After threshing clean the seed and dry to make the moisture level upto 8 %. Don't dry the seed in high temperatures at 40°C & above as it will decrease the germination percent. Don't mix any chemicals during the storage. Mix the ash @ 20 g. / kg or neem oil @ 20 ml / kg to keep the produce free from pests.

SUNFLOWER (*Helianthus annuus*)

Soils : The crop performs well on a wide range of soils such as sandy loams, black soils and alluvials. Fertile, well drained neutral soils are best. Ideal p^H 6.5 – 8.0. It can tolerate slight alkalinity but not acidity. Water logging areas should be avoided.

Recommended hybrids / varieties

S. No.	Hybrid/Variety	Duration (Days)	Yield (kg/ha) under rainfed conditions	Oil Content (%)	Special Characters
1.	NDSH 1012	90 - 95	1500 - 2000	40 – 41	High yield, high oil content, moderately resistant to downy mildew.
2.	LSFH 171	90 - 95	1600-1800	34 - 35	High yield, resistant to downy mildew
3.	DRSH-1	90-95	1500	42 - 44	High oil content.
4.	KBSH -44	95-98	1400	36-38	High yield
5.	DRSF-113	90-95	1200	40	High oil content.

Time of sowing

Kharif

Light soils : June II FN-July II FN
Heavy soils : June II FN – August

Rabi

Rainfed : September to First fortnight of October
Irrigated : November
Summer irrigated : 15th January to first week of February

Seed rate and spacing: Rain fed crop requires more seed (7.5-10 kg /ha for varieties and 5-6.25 kg for hybrids) than irrigated (6.25-8.75 and 5 kg/ha), respectively, for varieties and hybrids). In light soils, 45 x 20-25 cm and in heavy soils 60 x 30 cm is recommended.

Seed treatment Seed should be treated with quintal (iprodione 25 % + carbendazim 25 %) or saaf (carbendazim 12 % + mancozeb 63 %) @ 2 g/kg for managing *Alternaria* leaf spot. In the necrosis prone areas treat the seed with imidacloprid 600 FS @ 5 ml /kg or thiamethoxam @ 4 g/kg seed. Seed should be treated with metalaxyl @ 3 g/kg seed for managing downy mildew.

Thinning: Maintain a single seedling per hill by thinning out other seedlings in a hill, 10-15 days after germination for obtaining higher yields.

Fertilizers: Apply FYM 7.5 t/ha 2-3 weeks prior to sowing.

	N*	P	K (kg/ha)
Rain fed	60 (30+30)	60	30
Irrigated (Black soils)	75 (25+25+25)	90	30

- First dose as basal and second and third as top dressing at 30 and 50 days after sowing.
- Prefer single super phosphate as source of P

Water management: During *rabi*/summer irrigations can be given based on soil type. In light soils irrigation can be given 6-10 days interval while in heavy soils 15-20 days interval. Flower bud initiation, flowering and seed set are sensitive stages for irrigation.

Intercultivation

Use of pendimethalin @ 1.5 kg a.i/ha in 600 litres of water as pre-emergence spray followed by hand weeding at 35 DAS provides effective control of weeds. In case of incessant rainfall to manage grassy weeds spray Fenoxypop ethyl or Quizalofopethyl @ 1.25 ml/l at 25 DAS.

Plant protection

Insects

Sucking pests

Leafhoppers: Spray with acetamiprid @ 0.2 g or methyl demeton 25 EC @ 2 ml/l

Whitefly: Spray with diafenthiuron 50 % WP @ 1.25 ml/l or thiamethoxam 25 % WG @ 0.2 g/l or flonicamide @ 0.3 g/l

Thrips: Spray with imidacloprid 17.8 % SL @ 0.4 ml/l or thiamethoxam 25 % WG @ 0.2 g/l or fipronil @ 2 ml/l

Mealybug: Spray profenophos 50 EC @ 2 ml/l or quinalphos 25 EC @ 2 ml/l two times at 10-15 days interval

Tobacco caterpillar

Spray with spinosad @ 0.3 ml or novuluron @ 1 ml/l or flubendiamide @ 0.2 ml/l

Bihar hairy caterpillar

For management of early instars, sprays with NSKE 5 % and for grown up larvae, spray with chlorpyrifos 20 % EC @ 2.5 ml/l.

Gram pod borer

Spray with Ha NPV @ 250 LE/acre or spinosad 45% SC @ 0.3 ml/l or novaluron @ 1 ml/l or flubendiamide @ 0.2 ml/l

Diseases

***Alternaria* leaf spot/blight**

- For managing *Alternaria* along with seed treatment spray quintal (iprodione 25 % + carbendazim 25 %) @ 2 g/l or saaf (carbendazim 12 % + mancozeb 63 %) @ 2 g/l or taspa (difenconazole 25 % + propiconazole 25 %) @ 0.25 g or propiconazole @ 1 ml/l.

Head Rot: Spray wettable sulphur 80 % WP @ 3g /l or fenthion @ 1 ml/l twice within 10 days interval.

Downy mildew

- Remove infected plants and destroy.
- Spray metalaxyl 8 % MZ @ 2 g + mancozeb 64 % WP @ 2 g or copper oxy chloride 50 % WP @ 3 g/l.

Necrosis

- Summer ploughing should be done.
- Plant four rows of either sorghum or pearl millet or maize as border crop.
- Treat the seed with imidacloprid 5 g/kg or thiamethoxam 4 g/kg seed.
- Remove the parthenium weed around the bunds and also necrosis affected sunflower plants before flowering.
- To control the vectors, thrips methyl demeton 25 % EC @ 2 ml/l or imidacloprid 17.8 % SL @ 0.4 ml/l or thiamethoxam 25 % WG @ 0.2 g/l twice within 15 days interval.

Leaf curl : White fly acts as a vector. For managing whitefly, spray diafenthiuron 50 % WP @ 1.25 g/l or flonicamide 50 WG @ 0.25 g/l or thiamethoxam 25 % WG @ 0.2 g/l

Powdery mildew

Spray wettable sulphur 80 % WP @ 3 g/l or dinocap @ 1 ml/l or propiconazole @ 1 ml/l or difenconazole 0.5 g/l twice within 15 days interval.

Parrots: Bird scaring with reflecting ribbons.

Harvesting and storage: Harvest when back side of the head turns yellow. Thresh after drying for 2-3 days and store the seed with 9-10 % moisture.

SAFFLOWER (*Carthamus tinctorius*)

Soils and preparation: Heavy soils with good drainage are ideal. Acidic soils should be avoided but slight alkaline soils will be alright. Deep ploughing in summer followed by 2-3 harrowings during Kharif for fallows or two harrowings after *Kharif* pulse crop.

Seed and sowing

Variety/hybrid	Duration	Yield (kg/ha)	Special features
ISF 764	125-130	1583 (rainfed) 2274 (irrigated)	High oil (31 %) content
ISF 1	125-130	1236 (rainfed) 1864 (irrigated)	First released high oleic acid (76 %) variety. 31 % oil content
DSH 185	120-125	1600 (rainfed) 2250 (irrigated)	Tolerant to <i>Fusarium</i> wilt. 28-29 % oil content
SSF-12-40	122-125	1713 (irrigated)	Moderately tolerant to aphids. Suitable for irrigated situation. 32.9 % oil content.

Sowing should be taken in the month of October. If rains delayed sowing can be extended to November I FN. Seed rate is 10 kg seed/ha for sole crop or 4.5 kg/ha for intercropping with bengal gram or coriander in 1:2 ratio. Can be sown after treating each kg of seed with thiram/captan @ 3 g or carbendazim @ 1 g against wilt. Seed can be sown behind plough or with the drill at 5 cm depth in 45 cm x 20 cm spacing. Thinning is to be done 10-15 days after sowing keeping single plant per hill.

Fertilizers: Two to three weeks before sowing apply FYM @ 5 t/ha. 16 kg nitrogen and 10kg phosphorous providing fertilizers are to be applied as basal dose and in irrigated situation, apply 50 % of nitrogen as basal and 50 % remaining nitrogen providing fertilizers as top dressing at 5 weeks after sowing.

Weeding and Intercultivation: Intercultivation to be done at 25 and 40-45 DAS. Pendimethalin @ 1 l/acre in 200 L of water is recommended within 48 hrs of sowing as pre-emergence herbicide.

Irrigation: Stem elongation (30-35 DAS) and flowering (65-75 DAS) are the critical stages for irrigation.

Pest management

Leaf eating caterpillars: Spray with spinosad @ 0.3 ml/l or flubendiamide @ 0.2 ml /l of water

Aphids: Spray with beuprofezin @ 1.5 ml or flonicamide @ 0.3 g/l.

Disease management

Alternaria leaf spot: Spray mancozeb @ 2.5 g/l or propiconazole @ 1 ml/l as soon as spots appears and one more spray within 7-10 days after first spray.

Fusarium wilt: Rotate the crop with bengalgram to reduce intensity of *Fusarium* wilt. Cultivate tolerant varieties like DSH 185. Seed treatment with carbendazim @ 1 g or saaf (carbendazim 12 % + mancozeb @ 63 %) @ 2 g/kg seed is to be practiced.

Parrots: Damage will be severe for discrete small holdings which need scaring morning and evening during seed filling.

Harvest and storage: Harvesting in morning prevents seed shedding and spines will be soft. Threshing by tractor or beating with sticks and storing with 5-8 % moisture.

Harvesting petals 15-20 days after flowering can be done for herbal tea.

CASTOR

Soils:

- Castor can be cultivated on almost all types of well-drained soils.
- Saline soils and soils with water stagnation are not suitable.

Varietal Recommendation:

S. No.	Variety / Hybrid	Year of release	Duration (days)	Yield (q/ha)	Special Characters	Pest / Disease Resistance
Varieties						
1	Jyothi (DCS-9)	1995	90-150	5-6 (Rainfed) 6-7 (Irrigated)	Red stem, double bloom, spiny, early duration	Resistant to fusarium wilt
2	Kranthi (PCS-4)	1996	90-150	5-6 (Rainfed) 7-8 (Irrigated)	Red stem, double bloom, spiny capsules, early duration, good branching potential	Tolerant to drought
3	Haritha (PCS-124)	2002	90-180	5.5-6 (Rainfed) 7-8 (Irrigated)	Green stem, double bloom, spiny	Resistant to fusarium wilt and drought
4	Kiran (PCS-136)	2002	90-150	5-6 (Rainfed) 6-7 (Irrigated)	Red stem, double bloom, non-spiny	Moderately tolerant to <i>botrytis</i>
5	Jwala (48-1)	2007	90-180	5-6 (Rainfed) 7-8 (Irrigated)	Red stem, double bloom and non-spiny	Resistant to fusarium wilt and moderately tolerant to <i>botrytis</i>
6	PCS-262 (Pragathi)	2015	80-160	6-7 (Rainfed) 7-8 (Irrigated)	Red stem with and double bloom	High oil content and test weight, Resistant to <i>Fusarium fusarium</i> wilt
Hybrids						
1	GCH-4 (SHB-18)	1986	110-180	5-6 (Rainfed) 8-9 (Irrigated)	Red stem, triple bloom, semi spiny	Highly tolerant to jassids and tolerant to fusarium wilt
3	DCH-177 (Deepak)	2000	90-150	6-7.5 (Rainfed) 10-12 (Irrigated)	Red stem, single bloom, spiny	High yielding with resistance to fusarium wilt and whitefly but susceptible to jassids
4	DCH-519	2006	110-180	7-8 (Rainfed) 11-12 (Irrigated)	Green stem, triple bloom	High yielding with resistance to fusarium wilt and jassids
5	PCH-111	2010	90-180	6-7 (Rainfed) 9-10 (Irrigated)	Green stem, double bloom, spiny capsules	High yielding with resistance to fusarium wilt
6	PCH-222	2012	90-180	6-7 (Rainfed)	Red stem, double	High yielding with

				9-10 (Irrigated)	bloom, spiny capsules	resistance to fusarium wilt
6	ICH-66	2019	90-180	6-7 (Rainfed) 12-13 (Irrigated)	Red stem, triple bloom, semi spiny capsules	High yielding with resistance to fusarium wilt

Cropping systems:

- Castor+redgram (1:1) is the most predominant intercropping system among the farmers. It can also be intercropped with cowpea, greengram, cowpea, blackgram in (1:1) (1:2) and groundnut (1:5). Castor can be rotated with pigeonpea, cotton or groundnut.
- *Rabi* castor can be taken up as an ID (irrigated dry) crop during first week of October, there are ample chances of growing a short duration and remunerative crops maize or greengram during *kharif* season.
- Monocropping of castor cultivation in the same fields should be discouraged to avoid multiplication of fusarium wilt pathogen.

Sowing time:

- *kharif* season June 15th - July 15th and last cut-off date is July 31st.
- Under the conditions of delayed onset of monsoon, the crop can be sown up to first week of August but with little manipulation of agronomic practices like selection of varieties (Haritha, Kranthi and DCS-9), close spacing of 60x30 cm with 30% higher population and 25% more N than recommended dose and frequent inter cultivation after each rain to create dust mulch so as to reduce evaporation have to be adopted.
- *Rabi* castor - First fortnight of October for higher yields. the rainfall received during October month will be useful for proper germination, establishment, application of basal dose of fertilizer application and saves the cost of 2-3 irrigations.
- Delay in sowing from October 1st to November 15th results in decline in seed yield of castor by 21 to 44%, respectively.

Seed Rate and Sowing :

Situation	Seed rate (kg/ha)	Spacing (cm)
Rainfed	5.0	90 cm x 60 cm
Heavy soils, irrigated	5.0	90 cm x 90 cm or 120 cm x 60 cm
Light soils, irrigated	7.5	90 cm x 60 cm

Thinning of excess population @ 10-15 DAS by retaining one seedling per hill and maintaining the optimum plant population.

Nutritional Management:

- Basal application of FYM@5t/ha, for cultivation of varieties under rainfed conditions 60:40:30 kg of N: P₂O₅: K₂O/ha, where 30 kg of N as basal and remaining N in 2 equal splits at 30-35DAS and 60-65DAS. For Hybrids an additional dose of 15 kg N can be applied each time in irrigated condition during emergence of later order spikes.
- In case of Zn deficit soils (<0.6 ppm), the most visible deficiency symptoms are short internodes and a decrease in leaf size, delayed maturity and improper seed filling. To correct this, 0.5% ZnSO₄ at 50 and 90 DAS (days after sowing) has to be sprayed which helps in better growth and seed filling besides reducing sucking pest load.
- In case of integrated nutrient management which envisages conjunctive use of organic, inorganic and biological sources of nutrients for sustaining the soil health and crop

productivity, application of 50% RDF (recommended dose of fertilizer) + Seed treatment with *Azospirillum*+25% N through FYM is advocated for castor under rainfed conditions

Integrated weed management:

- Pre-emergence application of Pendimethalin @ 1.0 kg a.i. ha⁻¹ (1.3-1.6 l / ha) (within 2-3 DAS in the presence of soil moisture + post emergence application of Quizalofop-p-ethyl @ 50 g a.i. ha⁻¹ (300-400 ml ha⁻¹) + two times inter cultivation (IC)+ one hand weeding is the best IWM module to be adopted for weed management in castor.
- Farmers' practice of 90 cm x 90 cm crop spacing + 3 intercultivations + 1 hand weeding is also equally effective.

Irrigation:

Two supplemental irrigations during the dry spells @ 20 mm each through drip irrigation at primary and secondary development stages enhances the yield under rainfed conditions.

Soil water conservation measures:

Subsoiling @ 1 m distance immediately after receipt of summer showers, before sowing of the crop once in three years to break the subsoil hard pan for better moisture availability and enhanced root penetration.

Plant protection

Insects

Red hairy caterpillar

- For stopping the movement of grownup larvae from one field to another, digging a trench and dusting methyl parathion 2% dust or quinalphos 1.5 % dust (@ 1 kg per 70 m length)
- For grown up larvae sprays with monocrotophos @ 1.6 ml/l or dimethoate @ 2 ml/l.

Semilooper

- Hand picking and destruction of grownup larvae
- Sprays initially with neem oil @ 5ml/l
- For management of grownup larvae sprays with acephate @ 1.5 g or profenophos @ 2 ml/l or novaluron @ 1 ml or thiodicarb @ 1.5 g per litre of water

Tobacco caterpillar

- For early instars management spray initially with neem oil @ 5ml/l
- For management of grownup larvae (2nd instar) sprays with chlorpyrifos @ 2.5 ml/l or monocrotophos @ 2 ml/l
- For management of 3rd instar larvae sprays with acephate @ 1.5 g or profenophos @ 2 ml/l or thiodicarb @ 1.5 g per litre of water
- Poison bait preparation with rice bran 5 kg + jaggery 0.5 kg + 250 g thiodicarb or and distribution in the field at base of the plant in the evening hours

Shoot and capsule borer

- For management of this pest protective sprays with monocrotophos @ 2ml or acephate @ 1.5 g or indoxacarb @ 1ml per litre of water first at the time of flowering and later at capsule formation

Bihar hairy caterpillar

- For management of early instars, sprays with neem oil @ 5ml and for grown up larvae, spray with chlorpyrifos @ 2.5 ml/l or acephate @ 1.5 g/l.

Sucking pests

Leafhoppers: Early sprays with neem oil @ 5 ml/l and at later stages with monocrotophos @ 1.6 ml/l or dimethoate @ 2 ml/l or acephate @ 1.5 g/l

Aphids: Early sprays with neem oil @ 5 ml/l and at later stages with monocrotophos @ 1.6 ml/l or profenophos @ 1.5 ml/l or dimethoate @ 2 ml/l or Acetamiprid @ 0.2 g/l

Whitefly: Early sprays with neem oil @ 5 ml/l and at later stages with monocrotophos @ 1.6 ml/l

Serpentine leaf miner: Sprays with neem oil @ 5 ml/l

Diseases

Fusarium wilt

- Use tolerant varieties like Haritha, 48-1, Jyothi and hybrids like GCH-4, DCH-519.
- Treat the seed with thiram or carbendazim @ 3 g/kg.
- Intercropping with Redgram and crop rotation with bajra.
- As soon as disease appears drench carbendazim 1 g/l or copper oxy chloride 3 g/l.
- Removal and destruction of affected plants.

Botrytis Grey Rot

- Before and After cyclone warning is given in Radio/T.V., spray carbendazim @1 g/l or thiophanate methyl @ 1g/l or Propiconazole @ 1ml/l
- Remove infected spikes and destroy.
- Spray carbendazim @1 g/l g/l or thiophanate methyl @ 1g/l or Propiconazole @ 1ml/l
- Apply 50 kg urea and 25 kg potash/ha after cessation of rains

Maturity and Harvesting

- Castor is an indeterminate plant and is characterized by sequential flowering and spike formation. So, different order spikes come to maturity at different times. But, harvesting of matured spikes at right time before the seeds fall on the ground, is very important.
- The spikes can be harvested at physiological maturity or when colour of 60-70% of the capsules in a spike change from green to light yellow or brown. Yield loss will be significant if harvesting is delayed until all capsule in the spikes are fully dried.
- In view of labour shortage utilization of castor threshers will reduce the damage to the capsules and increases the efficiency of threshing operation resulting in the more out turn and also more remunerative price. Nearly 12 labour and 10 hours' time per hectare can be saved due to mechanization of harvesting and threshing.
- Seeds has to be dried for 2-3 days till they attain safe moisture content of 9-10% and finally seeds are stored in gunny bags.

NIGER

Time of Sowing: Second fortnight of August to first half of September is ideal. Late sowing can reduce yields due to possible drought in critical period of flowering and seed setting.

Soils and land preparation: Light soils with moisture retention and drainage feasibility are suitable. Two to three ploughings with incorporation of 2.5 t/ac of FYM in last ploughing are needed. Pre- sowing application of fluchloralin @ 400 g a. i. /acre prevents germination of *Cuscuta* seed already prevailing in the soil.

Seed rate: 2 kg /acre.

Varieties

S.No.	Varieties	Duration (days)	Yield (kg/acre)
1	JNS 28	100-110	250-300
2	JNS-30	100-110	200-280
3	KGN 2	95-110	200-220

Sowing: Prefer line sowing instead of traditional broadcasting method. Follow spacing of 30 cm between rows and 10 cm within row. Eliminating *Cuscuta* seeds by sieving with 0.85 to 1.00 mm sieve or soaking 2 kg seed in 20 litres of salt (2 kg) water is essential.

Weeding: Pre-emergence application of pendimethalin @ 1.30 L /acre is recommended to control *Cuscuta* and other weeds. Removal and destroying of *Cuscuta* at the early stage of crop growth, prior to flowering, is to be done to prevent nutrient loss and further spread of this parasitic weed.

Fertilizers: Apply 1-2 t FYM per acre in last tilth. Application of 8 kg N/acre as Urea at 15- 20 days after sowing will give additional yields upto 80 kg/acre.

Pest management: Though the pest problem is less for this crop, under favourable conditions pest menace is possible. Removal of egg masses and larvae of defoliators such as *Spodoptera* is eco-friendly approach. Spraying of phosphomidon @1ml/l for sucking pests is suggested. Spraying mancozeb @ 2.5 gm/l at 15 days interval controls *Alternaria* blight.

Harvesting: Cutting plants to the ground level after heads and leaves turns black, followed by threshing by beating with sticks and drying the seed for 3-5 days are recommended for the safe storage.

SUGARCANE

Varieties

a. Early maturing	85 A261, 84 A 125, Co 8014, 83 A 30, 87 A 298, 99 V 30, 86 V 96, 91 V 83, 2000 V 59, 2003 V 46, 93 A 145, 97A 85, 2001 A 63, 2003A 255, 2005A 128, 2009V 127 (Ranga) and 2005T 16.
b. Mid-late maturing	Co T 8201, Co A 7602, Co 7805, 83 V 15, 86 A 146, 88 A 162, 2002 V 48, 98 A 163 and 2000 A 225
c. Late maturing	Co 7219, Co 7706 and 87 A 380
d. Moisture stress	Co T 8201, 87 A 298, 97 A 85, Co 7219, CoA 7602, 98A 163, 2005T16 and 2000A 56.
e. Saline – Alkaline soils	Co T 8201, Co 7219, 97 A 85, 93 A 145, 99 V 30, 2005T 16, 2003V46 and 2009V 127.
f. Water logging	CoT 8201, 87A 298, 83V 15, 2000V 59, 2003V 46 and Co 7805

Soils: Alluvial and well-drained loamy soils.

Land preparation Soils are to be worked to fine filth to a depth of 20-25 cm. Form furrows of 30 cm width and 20 cm depth by cattle drawn victory plough or tractor drawn ridgemar.

Seed rate: 16,000 three budded setts 4 tonnes per acre. Seed from short crop of 6-7 months age ensures good germination and improve cane yield by 2-3 tonnes/acre

Seed sett treatment: Dip the setts in carbendazim (0.5 g/lt) and chlorpyrifos 20 EC (2 ml/lt) or dimethoate (2ml/lt) or imidacloprid 48% FS @ 1 ml/lt for 15 minutes to eliminate pineapple disease and scale insect.

Spacing: 80 cm between rows for early varieties and 90 cm for mid-late varieties. Adopt paired row planting (60cm x 120 cm) to promote mechanization and drip irrigation.

Time of planting:

Early varieties: December – January

Mid varieties: February

Late varieties: March

Fertilizer management: Farm yard manure @ 10 tonnes per acre or press mud cake @ 5.0 tonnes per acre in the last ploughing. 90 kg nitrogen / acre (pocket application) is to be applied in two equal split doses at 45 and 90 days after planting.

Plant crop: 100 kg P₂O₅ and 120 kg K₂O/ha as basal and 168 kg N/ha in two equal split doses at 45th and 90th day after planting by pocketing.

Ratoon crop: 100 kg P₂O₅ and 168 kg K₂O and 280 kg N/ha. Entire dose of P₂ O₅ and K₂O with 140 kg N at the time of ratooning and the remaining 140 kg N at 45 days after ratooning. Zinc sulphate (2g / L) and ferrous sulphate (10-20 g/L) as foliar spray at 45- 60 days after planting where zinc and iron deficiencies are observed.

- Use of biofertilizers like azatobactor (4kg/acre) or azospirillum (4kg/acre) saves nitrogen to an extent of 25%
- Use of phospho bacteria (4kg /acre) and VAM (5kg /acre) saves phosphorus to an extent of 20 to 25%.
- Supply of recommended N&K fertilizers through drip fertigation in the form of Urea and muriate of potash (white potash) in 20 splits at weekly interval commencing from 30 DAP to 180 DAP is to be done to improve fertilizer use efficiency.

Weed management:

Pre emergence: Spray Atrazine @ 2 kg/acre or metribuzine @ 600 g/acre in 450 lts of water on the third or fourth day after planting, depending on soil moisture.

Post emergence: Spray 2,4-D (1.8 kg) + Gramoxone (1.0 lt) in 450 lts/ac at 20 & 60 DAP between cane rows with hood to protect the crop or spray metribuzine @ 400 g + 2,4-D Sodium salt @ 800 g /acre at 25-30 DAP as blanket application. For control of creeper weeds spray metsulfuran methyl + chlorimuron ethyl (Almix) @ 8.0 g/acre at 75 days after planting.

Other cultural operations:

1. Inter cultivation between 45-60 DAP control weeds besides improving aeration.
2. Earthing up at about four months after planting.

Keep the crop erect by TT propping twice or thrice depending upon crop growth leaving 6-8 green leaves in the crown.

Irrigation: Once in six days during summer and once in 15-21 days from November to harvest. During grand growth period, irrigation is to be provided when dry spell exceeds 15 days. If, only one irrigation is possible during formative phase, it has to be given at 30 days after planting and trash mulching has to be done three days after planting @ 1.25 t/acre.

Harvesting: Crop is to be harvested at peak maturity depending upon variety, date of planting and juice quality.

Post-harvest management: Sugarcane harvested in a field should be free from root material, soil etc., The immature top portion should be cut to the first visible top internode. Such dressed cane should be crushed within 24 hours either in a sugar factory or jaggery crusher to avoid loss in the cane weight and sugar recovery.

Management for single node seedling cultivation

In sugarcane, seed cost itself accounts for 15-20% of the total cost of cultivation. Generally, 4.0 tonnes of seed cane / acre is being used for getting optimum cane and sugar yields. Hence, to reduce seed cost and increase the cane production per unit area growing of sugarcane through single node seedlings is found to be the new innovative technology and becoming popular among the farming community.

Raising of seedlings in Nursery

Selection of seed cane

- For growing sugarcane seedlings high yielding varieties suitable for that particular region are to be selected. It is always better to use 6-7 months aged healthy short crop as seed material.

Preparation of single nodes from the seed cane

- Node cutting machines are available for separating single nodes from the cane.
- In traditional method of 3 bud sett planting, seed material of 4-6 t/ac is required. But in single node seedlings planting method, only 750-800 kgs of seed cane is sufficient for raising seedlings / acre.
- Selection of healthy and undamaged single nodes by grading method will not only improve germination percentage but also gives strong seedlings.
- Treat the single nodes with 0.5 g carbendazim + 2.5 ml chlorpyrifos or 1.6 ml monocrotophos/ liter of water for 15 minutes to reduce the incidence of pine apple disease and scale insect.
- Protrays (Plastic trays) having 48 pits can be used for sowing of single nodes.
- Fill the pits (half) with coco peat or well decomposed vermi compost + soil mixed in equal proportion. Then put the treated single buds keeping eye in upward direction. Then fill the trays completely with coco peat and press gently.

- Arrange trays in a shade net in such a way that each stack contains 10 trays and cover and tie with black polythene sheet tightly so that heat will be produced and germination of buds will be initiated.
- After 4-5 days, with the start of germination, arrange trays side by side in shade net and watering should be done in alternate days with rose can or sprinklers. Within one week all the buds will germinate. At 3-4 weeks after sowing every seedling will put forth 3-4 leaves with profuse root growth.

Preparation of main field and planting

- For planting one acre field, 7,500-8,000 seedlings are required. (150-175 plastic trays are sufficient). Growth and vigour of the seedlings also depends on type of rooting media used. Spray 19:19:19 @ 0.1% or vermi wash @ 1.0% to improve the seedling growth.
- Main field is to be thoroughly prepared by ploughing with 2 M.B. plough or rotavator and perfect leveling should be done.
- Furrows are to be formed at 60/120 cm spacing i.e. paired rows of 20 cm depth within the row and seedlings are to be planted at 60 cm distance. In the inter space between rows pulse crops like blackgram, greengram and groundnut can be grown which will improve soil fertility besides suppressing weed growth to certain extent. Drip system can be installed in the pairs to improve water use efficiency. While planting, seedlings are to be planted without disturbing root mass along with coco peat which holds moisture also
- Seedlings can also be planted with tractor drawn seedling transplanter.
- Light irrigations are to be given at 3-4 days interval at initial stages for quick establishment of the seedlings.
- Early planting in January – February is essential for good establishment of seedlings and synchronous tillering.

Nutrient Management

Application of fertilizers at frequent intervals up to earthing up (90-100 days) found to give higher cane yields as compared to traditional method of application.

- Apply 10 tons FYM per acre in last ploughing and incorporate into the soil.
- Single super phosphate @ 250 kg /acre is to be applied in planting furrows before planting
- Nitrogen @ 90 kg/acre is to be applied in four splits at planting 30, 60 and 90 days after planting by pocketing. Immediately after fertilization light irrigation is to be given to promote good tillering.

Agronomic practices like weed management, water management and other cultural operations are to be done as recommended for sett planted crop.

Ratoon crop management

Varieties: The same varieties indicated for plant crop are suitable for ratoon crop

Soils/Areas: Alluvial, red and well drained loamy soils

Stubble shaving and interculture: Plant crop is to be harvested to the ground level or just below ground level. Stubble shaving is to be done with spades without disturbing the stool. The interspaces have to be ploughed to 12 to 15 cm depth to break the crust and improve aeration for better ratooning.

Trash mulching: Trash mulching @ 1.25 t/acre at 3-5 days after ratooning ensures conservation of soil moisture and suppression of early shoot borer and weed growth.

Manures and fertilizers: Additional dose of 45 kg Nitrogen /acre over the dose recommended for plant crop is to be applied in two splits at ratooning and 45 days later. P₂O₅ @ 40 kg / acre

and K₂O @ 48 kg / acre are to be applied at the time of ratooning. If deficiency of iron is noticed ferrous sulphate @1.0% is to be sprayed on foliage immediately.

Gap filling: Gap filling has to be done with seedlings raised in polythene bags or in nursery from single nodes within two weeks after ratooning.

Weed management: Weeding and hoeing at 1st, 4th and 7th week after ratooning or spraying Atrazine @ 2.0 kg / acre or metribuzine @ 600 g/acre in 450 litres of water immediately after ratooning control the weeds effectively. Post emergence weedicides recommended in plant crop can be used in ratoon crop also.

Harvesting: Ratoon crop matures earlier than plant crop. Therefore, ratoon crop is to be harvested earlier than plant crop at peak maturity.

Management under saline / alkaline conditions

Varieties: 83V 15, 93 A 145, 97 A 85, Co T 8201, Co 7219 and 2005T 16.

Land preparation: Deep ploughing is to be avoided while other aspects are similar to plant crop

Seed rate: 18,000 three budded setts per acre. Seed material should be selected from mature crop

Planting time:

Early planting: December – January

Manures and fertilizers: Gypsum is to be applied @ 0.8-2.0 t/acre depending on P^H ranging from 8.5 – 9.2. Farm yard manure @ 10 t/acre or press mud cake @ 5 t/acre and Zinc sulphate @ 20 kg /acre are to be applied in the last ploughing. P₂O₅ @ 40kg / acre and K₂O @ 48 kg / acre for early planted crop and 20 kg K₂O / acre for late planted crop at the time of formation of ridges and furrows. For early planting, Nitrogen @ 90 kg/acre in two splits at 60 and 120 days after planting should be applied.

Inter cultivation and other management practices

- i. Provision of drainage and leaching with good quality water.
- ii. Trash mulching @ 1.25 t/acre three days after planting.
- iii. Earthing up at 4 months after planting and trash twist propping 2-3 times depending upon the growth of the crop.

Irrigation:

For early planted crop – once in six days during summer and once in 15-21 days from November to harvest. During rainy season if dry spells prevail for more than 15 days one to two irrigations may be provided.

Late planted crop is usually rainfed. Yield can be improved with supplemental irrigation during post monsoon period.

Harvesting: Crop is to be harvested at peak maturity depending upon variety, date of planting and juice quality.

Management of pests and diseases

Insect Pests

Early shoot borer

- Planting of setts in deep furrows.
- Application of carbofuran 3 G @ 10.0 kg/acre or Fipronil 0.3 G @ 10 kg/acre or chlorantraniliprole 0.4G @ 9kg/acre at the time of planting.
- Trash mulching @ 1.25 t/acre at 3 days after planting in plant crop and immediately after stubble shaving in ratoon crop.
- Irrigate the crop at frequent intervals during summer.

- Spray chlorpyrifos (2.5 ml/lt) or monocrotophos (1.6 ml/lt) or acephate (1g/lt) at 4, 6 and 9 weeks after planting with 450, 675 and 900 lts of spray fluid respectively. In endemic areas, spray chlorantraniliprole 18.5SC @ 0.3 ml/lt at 30 and 60 days after planting.
- Early ratooning in the months of December – January coupled with closer irrigations in the formative phase of the crop.
- Use synthetic pheromones in water traps @ 3 /acre for monitoring of the pest or 10 /acre for mass trapping of sugarcane borer (male) moths commencing from 20 days after planting or ratooning.
- Release egg parasitoid, *Trichogramma chilonis* four times @ 20,000/acre / release commencing from 30 days after planting or ratooning and subsequent releases at 7-10 interval.
- Release of heat tolerant *Trichogramma chilonis* @ 20,000/acre / release from 30 days after planting or ratooning, 4-6 times at 7–10-day interval in March – April planted/ ratoon crop.

Internode borer

- Control early shoot borer in early stages of the crop growth.
- Detrash the crop to destroy the larvae and pupae attached with the leaf sheaths.
- Remove water shoots at eighth/ ninth month age.
- Avoid high dose of nitrogen
- Drain out excess of water in low-lying areas.
- Use synthetic pheromones in water traps @ 3 /acre commencing from the internode formation stage of the crop for monitoring of the pest.
- Release egg parasitoid, *Trichogramma chilonis* @ 20,000/acre (2-4 times) at fortnightly intervals from 120 days after planting.
- Spray chlorpyrifos (2.5 ml/lt) 0.05 % or monocrotophos (1.6 ml/lt) or acephate (1 g/lt) twice at 15 days interval during June-July months.

Scale insect

- Dip the three budded setts in dimethoate (2 ml/lt) or imidacloprid 600 FS (1ml/lt) for 15 minutes before planting.
- Detrash the cane in the first week of July, August and September months followed by spraying with dimethoate (1.7 ml/lt) acephate (1g/lt) or imidacloprid @ 0.25 ml/lt.
- Dimethoate is preferred for spraying during heavy rains.
- Avoid ratooning of plant crop affected with heavy scale infestation.

Mealy bug

- Avoid ratooning of the plant crop infested with mealy bugs.
- Destroy alternate host plants (certain grasses like *Cymbopogon*) near sugarcane fields.
- Avoid excess usage of nitrogenous fertilizers.
- Avoid multi ratooning in areas prone to mealy bug.
- Detrash the grown-up crop and spray dimethoate @ 1.7 ml/lt or imidacloprid @ 0.3 ml/lt by using foot sprayer with long lance.

White fly

- Provide adequate drainage facilities
- Heavy rainfall washes out the pest.
- Apply 'N' fertilizers at recommended dose at stipulated time.
- Avoid ratooning in low lying areas prone for water logging.
- Spray chlorpyrifos @ 2.5 ml/lt or monocrotophos @ 1.6 ml/lt or imidacloprid

- 0.3 ml/lt using foot sprayer with long lance.

Termites

- Systematic digging of termite mounds and destruction of queens.
- Apply Fipronil 0.3G @10 kg/acre or chlorantraniliprole 0.4G@ 8.0 kg/acre in furrows at the time of planting.
- Spray imidacloprid 600 FS @ 1 ml/lt or chlorpyrifos 20 EC @ 5ml/lt wherever damage is noticed in standing crop
- Sett treatment with imidacloprid 600 FS @ 1 ml/litre for 15 minutes followed by soil drenching imidacloprid 600 FS @ 100 ml in 180 litres water in one acre field
- at planting.
- Soil application of Biopesticide, *Metarhizium anisopliae* (ICAR – NBAIR Ma4)
- @ 2 kg per acre mixed with 100 kg farm yard manure at the time of planting or ratooning in termite endemic fields.

Cane fly/ Pyrilla

- Detrash the lower leaves
- Use nitrogenous fertilizers Judiciously.
- Prevent lodging by timely TT propping.
- Spray dimethoate 1.7 ml/lt or monocrotophos @ 1.6 ml/lt with foot sprayer
- Release *Epiricania melanoleuca* 1800-2000 cocoons/acre or 1.8 to 2.0 lakhs eggs per acre.
- Avoid spraying of insecticides, if, parasitisation of *Epericania* is observed in the field.

Mites

- Removal and destruction of infested leaves
- Removal and destruction of grasses on the bunds.
- Spray wettable sulphur (50%) @ 3g/lt or dimethoate @ 1.7 ml/lt at 15 days interval starting from the appearance of the pest on crop as well as grassy weeds.
- Adopt balanced nutrition.
- Provide frequent irrigations during the pre-monsoon period.

Woolly aphid

- Harvest affected matured crop on priority basis.
- Avoid ratooning, if the plant crop is heavily infested with woolly aphid.
- Adopt paired/wider row planting.
- Removal and burning of affected leaves.
- Wrapping and propping of canes to avoid spread of pest.
- Use Nitrogenous fertilizers and irrigation water judiciously.
- Provide proper drainage.
- Conserve the existing natural enemies like *Chrysoperla carnea*, Syrphid fly, Brown lace wing, *Micromus timidis* (Ord.Neuroptera) and *Dipha aphidivora* (Ord. Lepidoptera). Release the bioagents if infestation is severe.
- Monitor the pest incidence through yellow traps.
- Spray monocrotophos @ 1.6 ml/lt. or dimethoate @ 1.7ml/lt or chlorpyrifos @ 2.5 ml/lt. or methyl demeton @ 2ml/lt. or acephate @ 1g/lt on lower surface of leaf.

Root grub

- Keeping light traps in root grub endemic areas for adult control.

- Apply Fipronil (10 kg/acre) or chlorantraniliprole (8 kg/acre) at planting / ratooning in endemic areas.
- In standing crop, flooding of fields for 2-3 days is effective in reducing the severity.
- Avoid ratooning of infected fields.
- Soil application of entomopathogenic fungi, *Metarhizium anisopliae* (ICAR – NABIR Ma4) @ 2 kg per acre mixed with 100 kg farm yard manure at planting or ratooning or at onset of monsoon rains two times at one month interval in root grub endemic areas.
- Soil application of entomopathogenic nematode, *Heterorhabditis indica* (ICAR –NBAIR H-38) @ 12 kg per ha mixed with 150 kg moist sand two times at one month interval at planting / ratooning, at onset of monsoon rains.

Fall army worm

- Weed management with pre-emergence / post emergence herbicides.
- Egg masses and larvae should be handpicked and destroyed.
- Spraying of 5% neem oil to prevent oviposition and larval feeding.
- Judicious use of insecticides recommended for use in sugarcane like chlorpyrifos 20 EC 2.5 ml or monocrotophos @ 1.6 ml or chlorantraniliprole @ 0.3 ml/ L of water ensuing that the spray fluid is directed to the whorls.
- In single node seedlings, treatment of seedlings should be with insecticide prophylactically with monocrotophos (1.6ml/lt) or chlorantraniliprole 18.5SC (0.3ml/lt) after inspection for the presence of damaging stages.

Diseases

Smut

- Systematic eradication of smutted clumps.
- Avoid second ratoon if incidence is severe.
- Treat three budded setts in hot water at 52⁰ C for 30 minutes or aerated steam at 51⁰ C for two hours followed by dipping setts in Propiconazole and raise special seed nurseries.
- Treat the setts with propiconazole (1 ml/lt) or hexaconazole (2ml/liter) for 15 minutes before planting the susceptible varieties like 87A 298, Co 6907.
- Spray propiconazole (1.0 ml/lt) immediately after ratooning and 30 days after 1st spray in ratoon crop.

Red rot

- Select healthy seed material from disease free areas
- Avoid ratooning of infected plant crop
- Provide good drainage and avoid stagnation.
- All stubbles and debris should be burnt and further cane planting should not be done up to four months in the infected field.
- Harvest the infected crop as early as possible and burn the crop residues.
- Keep the crop erect without lodging by trash twist propping.
- Grow red rot resistant varieties.
- Soil application of Trichoderma asperellum @ 5 kg along with 200 kg FYM to reduce the soil inoculum of red rot as well as soil borne pathogens

Grassy shoot disease

- Uproot and destroy affected clumps.
- Avoid ratooning of severely affected plots.

- Treat the setts in hot water at 52⁰ C for 30 minutes or aerated steam at 50⁰ C for one hour and raise special seed nursery.
- Spray dimethoate (1.7ml/lit) or monocrotophos (1.6ml/lit) to check vector population.

Pineapple disease

- Treat the setts by dipping in carbendazim solution (150 g of Carbendazim in 300 litres of water for 40,000 three budded setts sufficient to plant in one hectare).

Wilt

- Provide frequent irrigations during summer
- Avoid water logging / moisture stress
- Use disease free seed material
- Control the diseases and pests effectively to avoid primary infection
- Apply recommended dose of nitrogen within the stipulated time
- Apply talc-based formulation of *Trichoderma asperellum* @5 kg/acre along with 200 Kg FYM in planting furrows in endemic areas.

Top rot

- Two sprays of mancozeb (3 g/lit) at 2-3 weeks interval during rainy season.

Ring spot

- Spray either carbendazim (0.1%) or mancozeb (0.3%) or copper oxychloride (0.04 %) twice or thrice at 2 weeks interval starting from the first appearance of disease.

Rust

- Spray tridemorph @1 ml / lit. or Mancozeb @ 3 g/ lit. at 15 days interval starting from the first appearance of disease.

Viral diseases (YLD and Mosaic)

- Uproot and destroy affected clumps
- Avoid ratooning of severely affected crop
- Use disease free seed material, preferably cane raised from tissue culture seedlings
- Spray dimethoate @1.7ml/lit or monocrotophos @ 1.6ml/lit to control vector population (aphid)

COTTON (*Gossypium hirsutum*)

Desi Cotton Varieties (<i>G.arboreum.L</i>)	Aravinda, Srinandi (NDLA-2463), Yaganti (NDLA-2933) and Jayadhar
American Cotton Varieties (<i>G. hirsutum L.</i>)	Kanchana (LPS 141), LK-861, L-389, L- 603, L-604, Narasimha (NA-1325), Sivanandi (NDLH-1755), NDLH-1938 and LHDP cotton 1.
Intra-specific Cotton Hybrids	LAHH-5, Lam Cotton Hybrid-7, NDLHH-390 and NDLHH-240. LAHB cotton 1
Egyption Cotton Varieties / Inter-specific Cotton Hybrids	Suvin / Jayalakshmi (DCH-32) and LAHB cotton 1
Bt. Cotton Hybrids	Officially identified private Bt cotton hybrids being cultivated and found suitable for the past 3-4 years.
Soils	Deep black Cotton and red fertile soils with irrigated or assured rainfall conditions.

Land Preparation

For rainfed cotton, deep ploughing once in 3 years with mould board plough or disc harrow facilitates deep infiltration of water and charging of soil profile with large quantities of water. The land has to be ploughed 2 to 3 times and work with harrow to bring the soil to good tilth. Seeds can be dibbled by maintaining spacing in between plants after running a marker in one or two direction(s). For irrigated crop, ridges and furrows are to be formed at recommended spacings after deep ploughing.

Seed Rate

Amerrecian Cotton Varieties (<i>G.hirsutum.L</i>)	:	2 kg / acre
Desi Cotton Varieties (<i>G.arboreum.L</i> and <i>G.herbaceum.L</i>)	:	4-5 kg / acre
Intra-/Inter-specific Cotton Hybrids /Bt. hybrids	:	0.75-1 kg / acre

Seed Treatment

For acid delinting, seed should be treated with 80-100 ml H₂ SO₄ per kg of seed for 2-3 minutes followed by lime solution and thorough washing with water 2-3 times to make the seed acid free. Seed treatment with appropriate insecticide, Imidacloprid 600 FS @ 9 ml/kg + *Pseudomonas fluorescens* @ 10 g / kg or *Trichoderma viride* or *T. harzianum* @ 8 g / kg or carboxin 75 WP @2g/kg of the seed.

Spacing

Desi Cotton Varieties (cm)	:	60 x 30
American Cotton Varieties (cm)	:	90 x 60 or 105 x 60
Conventional Hybrids (cm)	:	90 x 60 or 120 x 60
Bt. Cotton Hybrids (cm)	:	90 x 45 or 90 x 60 or 120 x 45 or 120 x 60

Sowing with Cut-off dates

Red soils	:	June – 1 st Fortnight of July
Black soils	:	July – 1 st Fortnight of August

Inter Cropping in Cotton

Inter cropping with mungbean / urdbean / soybean / cluster bean in 1:2 or 1:3 ratio and pigeonpea 4:1 or 6:1 or 8:1 ratio.

Gap filling and Thinning

Gap filling should be done preferably within 10 DAS. Thinning should be done within three weeks after sowing retaining two plants per hill in case of varieties, one plant per hill in case of hybrids.

Nutrient Management: Use of organic manures and growing of green manure crops including *in situ* green manuring of sunhemp etc. for improving of soil organic matter content of the soil.

Zone wise Nutrient recommendation for cotton for A.P. are as follows

Season	Variety/ hybrid	Total- N (kg/ha)	Split applications at days (N)			P ₂ O ₅ Entire Basal	K ₂ O	Split application at days (K)		
			30	60	90			30	60	90
Coastal										
<i>Kharif</i>	Varieties (Hir)	90	30	30	30	45	45	15	15	15
	Hybrids (HxH))	120	40	40	40	60	60	20	20	20
	Bt Hybrids	150	50	50	50	60	60	20	20	20
Rayalaseema										
<i>Mungari</i>	Varieties (<i>Desi</i>)	20				20				
	Varieties (Hir) (Rainfed)	40	20	20		20				
	Varieties (Hir) (Irrigated)	90	30	30	30	45	45	15	15	15
	Hybrids (HxH))	120	40	40	40	60	60	20	20	20
	Bt Hybrids	150	50	50	50	60	60	20	20	20

Band placement of fertilizers at 5 cm depth and 5cm away from the plant for efficient utilization is suggested.

Micro-Nutrient disorders and their correction

Mg: Mg deficiency in cotton is common in highly calcareous soils and soils having high K or soils fertilized with high K fertilizers. In Mg deficiency the older leaves become yellow from the margins, while the veins remain green. The leaves finally dry and fall.

Correction: Spray 1% Mg SO₄ (10 g/l) twice at 45 and 75 DAS

Zn: Zn deficiency is seen on middle leaves. Veins remain green. Interveinal area becomes yellow. Terminal leaves become small and clustered and inter nodal distance decrease. This is usually observed in calcareous, low organic matter, high P soils.

Correction: Apply 50 kg ZnSO₄/kg in the last plough. If the deficiency is seen on the crop, spray 0.2% ZnSO₄ 2-3 times or 0.1% chelated Zn 2-3 times till the plants become normal.

Boron: Boron deficiency is predominant in all places of cotton cultivation in A.P. Boron is very important to cotton crop through out its growth. Deficiency occurs in drought season/due to floods or in calcareous soils.

Deficiency: Change in the size of flowers and petioles, formation of small squares. Petioles irregular, thick and thin with pink coloration, and cracks, flowers and bolls drop.

Correction: Spray borax or boric acid @ 1-1.5 g/l) of at 60 and 90 DAS twice. If the problem is recurring in the same field, broadcast 1 kg/ha of borax mixed with 50 kg sand or soil in lines for uniform distribution at sowing for next crop.

Flooded /water logged condition: When the crops are waterlogged for about a week, spray 1% urea or 1% KNO₃ solution for rejuvenation has to be done.

Weed Management

The first 60 days after sowing is very critical for weed competition. For effective weed control spray pendimethalin @ 1.5 to 2.0 l/acre immediately or within 48 hours of sowing. Inter cultivation with tyned harrow and blade harrow 2-4 times up to 90 DAS. For control of the grasses and broad leaved weeds post emergence spray of quizalofopethyl @ 400 ml/acre (2 ml/l) and pyriithiobac sodium @ 250 ml / acre (1.25 ml/l) is recommended at 25-30 DAS. Post emergence directed spray of paraquat @ 5.0 ml/l of water is recommended for control of the weeds in the cotton crop, where inter-cultivation or manual weeding is not possible due to unfavourable weather conditions.

Irrigation: Generally cotton crop requires 2-4 irrigations depending upon the soil type. Square formation, flowering and boll development stages are critical for moisture stress. For moisture conservation and effective weed control furrows for every row or alternate rows should be opened during the last inter cultivation operation.

Pest Management in Cotton

Management of Sucking Pests in cotton

- Grow sucking pest tolerant / resistant varieties or hybrids.
- Seed treatment Imidacloprid 600FS @ 9 ml /kg + *Pseudomonas fluorescens* @ 10 g / kg or *Trichoderma viride* or *T. harzianum* @ 8 g / kg or carboxin 75 WP @2g/kg of the seed.
- Growing of intercrops like mungbean or urdbean or soybean or cluster bean in 1:2 or 1:3 ratio will facilitate the buildup of native natural enemy populations and in turn keep sucking pests under check
- Growing of cowpea as bund crop is advantageous to encourage predatory insects like coccinellids, syrphids and chrysopids
- Maize or sorghum or pearl millet grown as barrier crops on the border prevents spread of insect pests from neighbouring fields.
- Stem application at 30 & 45 DAS with monocrotophos (1:4) and at 60 DAS with imidacloprid (1:20) for protecting the crop from early season sucking pests is highly effective.
- Setting up of yellow sticky traps @ 10 per acre for monitoring whitefly incidence and blue sticky traps @ 10 per acre for monitoring thrips incidence.
- Economic Threshold Level (ETL) for sucking pests on cotton is presented hereunder :

Name of the Pest	ETL
Jassids	Two adults or nymphs per leaf or appearance of second grade injury (yellowing in the margins of the leaves)
Thrips	10 adults per leaf
Aphids	15% affected plants
Whiteflies	6-8 adults per leaf
Mealy bugs	5% affected plants
Mites	10 per cm ⁻¹

ETL based application of insecticides

Leafhoppers / aphids / thrips

Monocrotophos 36 SL @ 1.6 ml/l or
 Acephate 75 SP @1.5g/l or
 Imidacloprid 17.8 SL @ 0.4 ml/l or
 Acetamiprid 20 SP @ 0.2 g/l or

Whitefly

Thiamethoxam 25 WG @ 0.2 g/l or
Fipronil 5 SC @ 2.0 ml/l
Diafenthiuran 50 WP @ 1.25 g/l
Flonicamid 50 WG @ 0.3 g/l
Acephate 75 SP @ 1.5 g/l or
Profenophos 50 EC @ 2.0 ml/l or
Acetamiprid 20 SP @ 0.2 g/l or
Diafenthiuron 50% WP @ 1.25 g/l or
NSKE @ 5% (extract from 10.0 kg of
Neem Powder/acre)

Red mite

Wettable sulphur 80 WP @ 3.0 g/l or
Dicofol 18.5 SC @ 5.0 ml/l

Integrated Pest Management in Cotton

1. Avoid monocropping of cotton.
2. Application of chemical fertilizers as supplement to organic or biological fertilizers as per the recommended doses.
3. Growing intercrops/strip crops/barrier crops with greengram, blackgram, soybean cowpea, clusterbean, groundnut, foxtail millet and coriander were found better intercrops in increasing the effectiveness of natural enemies like coccinellids, syrphids, chrysopids, spiders, *Trichogrammids*, *Apantelelids* etc. Growing fodder sorghum or maize as barrier crops and castor as ovipositional trap crop with in the cotton was also found to be more advantageous to manage the pests of cotton.
4. Seed treatment with recommended insecticides and fungicides.
5. Stem application of Monocrotophos at 30 and 45, and imidacloprid at 60 DAS.
6. Monitoring pests by using light, sticky and pheromone traps. The adults monitoring should be supported by egg and larval monitoring following sequential sampling technique at frequent intervals in case of boll worms.
7. Bird perches should be arranged @ 10 per acre for encouraging bird predation on bollworm larvae.
8. The buildup of broad spectrum predators *viz.*, spiders, coccinellids and chrysopids should be synchronised in other cultural operations. Release of *Trichogramma* egg parasite @ 60,000/acre should be done as soon as the first brood of bollworms are noticed.
9. Topping of cotton plants when maximum egg laying of *Helicoverpa armigera* is noticed (October-November months).
10. Application of HNPV @ 500 LE/ha or neem seed kernel extract (5%) in synchrony with early larvae of *Helicoverpa*. Neem oil formulation to manage initial whitefly.
11. ETLs for Bollworms

Name of the Pest	ETL
American bollworm (<i>H. armigera</i>) and Spotted Boll worm (<i>E. vitella</i>)	Five per cent damaged fruiting bodies or one larva per plant or total three damaged square per plant taken from 20 plants selected at random for counting.
Pink bollworm (<i>P. gossypiella</i>)	Eight moths per trap per day for three consecutive days or 10 % infested flowers or bolls with live larvae.
Tobacco caterpillar (<i>S. litura</i>)	One egg mass or skeletized leaf / ten

12. Poison bait (10 kg of rice bran + 2 kg jaggery + 500-750 ml of chlorpyrifos or 250-300 g of thiodicarb) for the control of grown up larvae of *Spodoptera*.
13. Resorting to chemical insecticides for the control of leafhoppers spray monocrotophos 36 SL @ 1.6 ml/l or acephate 75 SP @ 1.5 g/l or fipronil 5% SC @ 2.0 ml/l or imidacloprid 17.8 SL @ 0.4 ml/l or acetamiprid 20 SP @ 0.2 g/l or thiamethoxam 25 WG @ 0.2 g/l or flonicamid 50 WG @ 0.3 g/l. For the management of whitefly spray or profenophos 50 EC @ 2.0 ml/l or diafenthiuron 50 WP @ 1.25 g/l or neem seed kernel extract @ 5% or neem oil @ 5.0 ml/l; for the control of *Helicoverpa armigera* spray quinalphos 25 EC @ 2.5 ml/l or chlorpyrifos 20 EC @ 3.0 ml/l or acephate 75 SP @ 1.5 g/l or indoxacarb 14.5 SC @ 1.0 ml/l or thiodicarb 75 WP @ 1.5 g/l or spinosad 45 SC @ 0.3 ml/l or flubendiamide 48 SC @ 0.3 ml/l or chlorantraniliprole 18.5 SC @ 0.3 ml/l. For managing red spider mites, application of wettable sulphur 80 WP @ 3.0 g/l or dicofol 18.5 SC @ 5.0 ml/l. Similarly if mealy bugs spread in patches to alarming level spray acephate 75 SP @ 2.0 g/l or profenophos 50 EC @ 3.0 ml/l mixing with sandovit or teepol.
14. Removal of cotton stubbles after last picking without opting for ratoon crop or prolonging the crop growth with irrigations and fertilizer applications. This is essential to break the cycles of problematic pests in the system as a whole

Mealy bug management in Cotton

- Adopt crop rotation
- Removal and burning of alternate weed hosts like *Parthenium*, *Abutilon* etc. in the vicinity of cotton crop
- Control mealy bug population on the alternate crop hosts during and off season
- Stem application of monocrotophos diluted with water in 1:4 ratio during vegetative and early reproductive stage of the cotton crop at 30, 45 and 60 DAS as a prophylactic measure.
- Monitoring the initial infestation of mealy bug, particularly on border plants and shaded areas for timely control measures.
- Need based spraying of insecticides, profenophos 50 EC @ 3.0 ml/l or acephate 75 WP 2.0 g/l mixed with stickers like triton or sandovit or teepol etc @ 1ml/l of spray fluid
- Spot application of insecticides is desirable when the infestation is confined to isolated pockets in the field.
- Removal and destruction by burning of heavily infested dried / dead cotton plants may be taken up to arrest further spread of the pest incidence.
- Removal and burning of left over cotton stubbles after harvesting.

Management strategies for pink bollworm

ETL for Pink bollworm

- Eight moths per pheromone trap per day for three consecutive days.
- One rosette flower/ 10 flowers (10 % infested flowers).
- One live larvae / 10 bolls (10 % infested bolls).

Sampling technique

Scout cotton crop for PBW incidence and determine ETL through

Examination of 50 flowers across the whole field randomly for rosette flowers

Collect 20 bolls/acre randomly, not more than one boll per plant and cut open them for damage and larval presence at 10 days interval.

Integrated Management of Pink bollworm in Bt Cotton:

Off Season Practices

Certain off-season cultural practices which aim to maintain a host-free period play a key role in minimizing carry-over of pink bollworm to the succeeding season

- Gin sanitation: Destroy damaged seed trash by burying them in pits or through burning. Install four pheromone traps around the pile of waste lint from the gins to trap the emerging male moths
- Field sanitation. Pink bollworm larvae remain hidden in dried or improperly opened bolls. So, destroy leftover cotton stalks with dried/unopened green bolls by burying them in pits or through burning.
- Allow cattle, sheep and goats to graze upon immature green bolls and attacked bolls after final picking to prevent carry-over of the pest to the next season.
- Prompt removal and destruction of cotton stubbles to prevent carryover of pest to next season without stacking in the fields.
- Spread awareness on the importance of destroying pink bollworm damaged cotton seeds after ginning. These seeds could contain diapausing pink bollworm larvae hidden within the half-eaten seed.
- Destroy trashed and stained cotton with damaged seeds whether lying in the farmer's house or in the Gins. This is a rich and concentrated source of resting pink bollworm larvae.
- Avoid ratooning and summer cotton.
- Restrict the movement of cotton seed from other areas/states
- Crop rotation to break the life cycle of the pest

Pre Season Practices

This is the key period to create awareness amongst growers on the good agricultural practices which need to follow.

- Deep summer ploughing should be done to destroy the diapausing larvae of pink bollworm in soil and plant debris.
- Grow early maturing varieties so that the cotton bolls mature before the heavy population of pink bollworm builds up.
- Avoid staggered sowing in an area and take up timely sowings.

In season (June-January) Practices

- Monitoring for pest build up with pheromone traps @ 10 /ha. and random destructive sampling of green bolls.
- Mass trapping and mating disruption technique on wide area through integrated approach
- Destroy rosette flowers and remove the dropped squares, dried flowers and pre-matured bolls to suppress pest population periodically at the initial stage.
- Adopt efficient and timely agronomic practices such as use of organic manures and recommended doses of 'N' fertilizers only.
- Release of *Trichogramma* @ 60,000/acre at the time of peak flowering stage to facilitate the egg parasitism
- Need based use of insecticides: Spraying of insecticides like thiodicarb 75 WP @ 1.5 g/l or profenophos 50EC @ 2 ml/l or quinalphos 25 EC @ 2.5 ml/l or chlorpyrifos 20 EC @ 2.5 ml/l at 15 days interval.
- If the crop is at final stage, spray synthetic pyrethroids such as cypermethrin 10 EC @ 1.25 ml/l or lambda cyhalothrin 5 EC @ 1.0 ml/l (caution- Use of synthetic pyrethroids will increase the incidence of sucking pests).

- Timely crop termination without extending the crop through irrigation and fertilizers as late formed bolls may severely attract pink boll worm incidence and taking up the sequential crop depending up on the resources available.

Management of Cotton Diseases

Bacterial blight: Angular leaf spots develop and spread through veins causing vein blight. Under severe conditions disease spreads to branches causing black arm. Dark green spots develop on bolls which turn black and bolls rot.

Control: Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed; spraying copper oxy chloride 3.0 g/l + streptomycin 100 mg/l starting from 50 days after sowing, 2-3 times, at fortnightly intervals.

Alternaria leaf spot: Brown spots with concentric rings develop on leaves, join together and dry; defoliation occurs. Lesions on stem extend and break.

Helminthosporium leaf spot: Light brown spots with ashy centres and red margins

Cercospora leaf spot: Dark brown circular spots with white centres and purple margins develop on leaves.

Control: For the control of leaf spots seed treatment with *P. fluorescens* @ 10 g /kg of seed; spraying copper oxy chloride 3 g/l or propiconazole 1ml/l or hexaconazole 1g/l starting from 50 DAS, 2-3 times, at fortnightly intervals.

Grey mildew: Angular, white, powdery spots develop on leaves, spread and defoliation occurs.

Control: Spraying water-soluble sulphur 3 g/l 2-3 times, at 10-15 days interval.

Rust: Yellowish brown to reddish brown pustules develop on both sides of the leaves.

Control: Spraying water-soluble sulphur 3.0 g/l or propiconazole 1.0 ml/l, starting from 75 DAS, 2-3 times, at fortnightly intervals.

Boll Rots: Dark spots or lesions develop on bolls.

Control: Spray copper oxy chloride 3.0 g/l + streptomycin 100 mg/l, 2-3 times at 7-10 days interval.

Root rot: Sudden death of young plants in patches, roots become sticky and bark shreds in grown up plants.

Fusarium wilt: Damping off symptoms at seedling stage, lower leaves wilt early and drop. Brown streaks are visible in split open branches or stems, sometimes with black spores.

Verticillium wilt: Interveneal chlorosis and dark lesions develop on leaves with appearance of tiger stripes, brown discoloration is visible in split open stems, branches and also inside the bark, plants die in the centre of infected patch.

Control: Seed treatment with *Trichoderma viride* @ 10 g or *P. fluorescens* @ 10 g or soil application of *T. viride* or *P. fluorescens* @ 1 kg/acre developed in 90 kg FYM or vermicompost along with 10 kg of neem cake; balanced Nitrogen application and correcting micronutrient deficiencies; soil drenching at the base of infected plants with copper oxy chloride 3.0 g/l.

Harvesting

- *Kapas* from fully opened bolls should be collected during cooler times of the day.
- *Kapas* picked should be free from debris like dried leaves, dried bracts etc.
- *Kapas* from the first and last pickings should not be mixed with middle pickings, which are of better quality.
- *Kapas* damaged by bollworms should be picked separately.
- The cleaned *kapas* is to be graded and stored in heaps or in gunny boras in dry and well ventilated godowns.

Post-harvest handling of cotton

- It is essential that proper care is taken at various stages of handling and processing to ensure that the quality of cotton is not adversely affected so as to realize maximum price.
- Watering the *kapas* before weighing should be avoided.
- Admixtures of different varieties should be avoided. The admixture of the inferior type lowers the quality of the superior type, due to differences in the fiber quality traits.
- Only one variety of cotton should be heaped and packed to maintain the purity and quality of the cotton.
- For supply of high quality of cotton, proper packing should be done to protect from contamination and dampness.
- Storing in open yards at the market should be avoided.
- The seeds from insect attacked and immature bolls being more fragile get crushed during ginning resulting in staining of lint by the oil oozing out of the cut-seeds. This oil acts as a medium for growth of the micro-organisms which will destroy the lint. So, the insect infested *kapas* should be separated.

INTEGRATED WEED MANAGEMENT PRACTICES FOR *KHARIF* AND *RABI* **(2022-23)**

Weed control in different crops and cropping systems and the control of problem weeds in a given area, is feasible through adoption of IWM practices. Herbicide use should be only one of the options but not the only option. Any one or more weed control practices given below need to be integrated to prevent weeds or to achieve long term weed control in farmers' fields.

PREVENTIVE MEASURES TO REDUCE WEED DENSITY

- Deep ploughing after summer showers and need based land levelling once in 2-3 years will reduce the annual as well as perennial weeds like *Cyperus* and *Cynodon*.
- Repeated preparatory cultivation of land with gorru and guntakka before sowing by utilizing the early monsoon showers exhausts the weed seed in top layers of soil.
- Clean cultivation and keeping the farm surroundings weed free reduces the weed seed bank in the area.
- Crop rotation to be followed to avoid parasitic weeds like *Cuscuta*, *Orabanche*, *Striga* etc.
- Use of weed free crop seed for sowing, avoiding FYM infested with weed seeds for field application, will help in avoiding introduction of new weed seed in to fields.
- Destruction of left over weeds after crop harvest reduces the soil seed load for the next crop.

CULTURAL AND MECHANICAL METHODS

- Maintenance of optimum crop stand to achieve proper field coverage and to smother weeds with in the field
- Sowing the crops in lines to facilitate inter cultivation
- As far as possible inter cultivation by using different mechanical measures is to be done
- The left over weeds after adoption of different control measures (chemical) need to be hand pulled before seed setting in order to prevent weed seed bank in soil.

CHEMICAL WEED CONTROL

1. Rice

A) Direct sown Rice

i) Drill sowing in optimum soil moisture

Before sowing

When the fields are infested with weeds viz., *Cyperus spp.*, *Cynodon dactylon*, *Echinochloa spp.* and when the weeds are in active growing stage, spray 10 ml of paraquat dichloride 24% SL or 15 ml of glufosinate ammonium 13.5% SL or 10 ml glyphosate 41% + 10 g. Ammonium sulphate/ Urea per 1.0 litre of water. After 10-15 days, sowing can be done after ploughing under optimum moisture condition.

Pre emergence

- Spray pendimethalin 30% @ 2.50 to 3.75 l/ha or pretilachlor 50% @ 1.0 l/ha immediately after sowing or the next day.

Post emergence

- At 15-20 days after sowing, when grassy weeds like *Echinochloa spp.* are dominant, spray of cyhalofop butyl 10% @ 1.0 l/ha.
- At 15-20 days after sowing, when both grasses and broad leaf weeds are present, spray of bispyribac sodium 10% @ 200 ml/ha.
- After 30 days of sowing, when dicot weeds are problematic, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or 2,4-D amine salt 58% EC @ 0.75 to 1.0 l/ha @ or ethoxysulfuron 15% @ 125 g/ha.

- After 30 days of sowing, when both grasses and broad leaf weeds are present, spray metsulfuron methyl (10%) + chlorimuron ethyl (10%) @ 20 g/ha.

ii) Broadcasting or drum seeding in Puddled field

Pre emergence

- Oxadiargyl 80% @ 90 g/ha or pyrazosulfuron ethyl 10% @ 200 g/ha in 1.25 litres of water and apply as sand mix application (50kg sand/ha) in a thin film of water at 3-5 days after sowing.

For post emergence application, follow the package as given in the drill sown rice.

B) Transplanted rice

i) Nursery

a) Pre emergence

- In case of dry nurseries, spray pretilachlor 50% @ 1.0 l/ha immediately or within two days after sowing for the control of *Echinochloa* and other annual monocot and dicot weeds.
- In case of wet nurseries, mix oxadiargyl 80% @ 90 g/ha in 1.25 litres of water and apply as sand mix application (50kg sand/ha) at 3 to 5 days after sowing in a thin film of water.

B) Post emergence

- Spray cyhalofop butyl 10% @ 1.0 l/ha at 15 days after sowing for the control of *Echinochloa spp.*
- Spray of bispyribac sodium 10% @ 200 ml/ha at 15 days after sowing for the control of grasses and broad leaf weeds.

ii) Main field

Within 3 to 5 days after planting (as sand mix application at 50kg sand /ha):

- For the control of *Echinochloa* and other annual grassy weeds,
 - apply butachlor 50% @ 2.5 to 4.5 l/ha (or)
 - apply anilophos 30% @ 1.33 to 1.67 l/ha (or)
 - pretilachlor 50% @ 1.0 l/ha.
 - When both grasses and broad leaf weeds are present,
 - apply 2, 4-D ethyl ester 4% granules @ 10 kg ha⁻¹ + butachlor @ 2.5 l/ha (or)
 - 2, 4-D ethyl ester 4% granules @ 10 kg ha⁻¹ + anilophos 30% @ 0.70 l/ha (or)
 - 2,4-D ethyl ester 4% granules @ 10 kg/ha + butachlor 5% granules @ 10 kg/ha (or)
 - bensufuron methyl(0.6%)+ pretilachlor (6.0 %) granules @ 10 kg/ha (or)
 - oxadiargyl 80% @ 125 g/ha.
 - At 15-25 days after transplanting:
 - when both grasses and broad leaf weeds are present
 - spray bispyribac sodium 10% @ 250 ml/ha
- At 25-30 days after planting:
- when dicot weeds are problematic
 - Spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha (or)
 - Spray 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha (or)
 - Spray ethoxysulfuron 15% @ 125 g/ha
 - When grassy and dicot weeds are problematic
 - spray metsulfuron methyl (10%)+chlorimuron ethyl (10%) @ 20 g/ha.

2. MAIZE

Upland maize

Pre emergence: (immediately or within three days after sowing)

- Spray atrazine 50% @ 2.5 to 3.5 kg/ha (or)

- Spray alachlor 50% @ 3.75 to 5.0 l/ha (or)
- Spray pendimethalin 30% @ 2.50 to 3.75 l/ha (or)
- Spray oxyfluorfen 23.5% @ 500 ml/ha.

Post emergence: (at 20-25 days after sowing)

- For the control of dicot weeds, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha (or)
- When grassy and dicot weeds are problematic, spray topramezone 33.6% @ 75 ml/ha or tembotrione 34.4% SC @ 286 ml /ha.
- When Cyperus infestation alone is very high, spray halosulfuron 75%WG @ 90 g/ha as post emergence spray

Zero tillage maize in rice fallows

Pre emergence

- atrazine 50% @ 2.5 kg/ha + paraquat 24% @ 2.5 l/ha.
- spray atrazine 50% @ 2.5 kg/ha+ glyphosate 41% @ 4.0 l/ha (when perennial weeds are present)

Post emergence

- for the control of dicot weeds, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha.
- When grassy and dicot weeds are problematic, spray topramezone 33.6% @ 75 ml/ha or tembotrione 34.4% SC @ 286 ml /ha.

3. SORGHUM

- Spray atrazine 50% @ 1.5 - 2.0 kg/ha immediately after sowing or the next day.
- For the control of dicot weeds, spray 2, 4-D sodium salt 80% @ 0.75 to 1.0 kg/ha at 30 to 35 days after sowing.

Zero tillage sorghum in rice fallows

Pre emergence

- Spray atrazine 50% @ 1.5- 2.0 kg/ha+ glyphosate 41% @ 4.0 l/ha (or)
- Atrazine 50% @ 1.5-2.0 kg/ha + paraquat 24% @ 2.5 l/ha.

Post emergence

For the control of dicot weeds, spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha or 2,4-D amine salt 58% @ 0.75 to 1.0 l/ha.

4. RAGI

- Spray pendimethalin 30% @ 2.5 l/ha immediately after sowing or before transplanting
- Spray anilophos 30% @ 1.75 l/ha one week after transplanting ragi seedlings
- Spray 2,4-D sodium salt 80% @ 0.75 to 1.0 kg/ha at 25-30 days after transplanting ragi seedlings

5. KORRA

- Spray atrazine 50% @ 1.2 kg/ha immediately after sowing or within one or two days
- Spray metsulfuron methyl (10%) + chlorimuron ethyl (10%) @ 15.0 g/ha at 20-25 DAS.

6. PULSES

a) PULSES- UP LAND:

- Spray pendimethalin 30% @ 2.50 to 3.75 l/ha or alachlor 50% @ 3.75 l/ha as pre emergence application immediately after sowing or the next day.

- If grassy weeds are problematic, post emergence spray of fenoxaprop ethyl 9% @ 625 ml/ha or quizalofop ethyl 5% @ 1.0 l/ha or propaquizafop ethyl 10% @ 625 ml/ha at 20 days after sowing
- For the control of grasses and broad leaf weeds post emergence spray of imazethapyr 10% @ 500 ml/ha or fomesafen 11.1%+fluazifopbutyl 11.1%@ 1.0 l/ha at 15-20 days after sowing.
- For the control of grasses and broad leaf weeds after 25-30 days of sowing post emergence spray of acifluorfen16.5% + clodinafop propargyl 8% @ 1.0 l/ha.

b) Rice fallow blackgram

- For the control of *Echinochloa* spp. and broad leaf weeds, apply benthocarb @ 2.5 to 5.0 l/ha or pendimethalin 30% @ 2.0 to 3.75 l/ha immediately after removal of paddy sheaves as sand mix application followed by spraying of water up to 1000 l/ha depending upon the soil moisture condition. Prefer pendimethalin for fields infested with cuscuta.
- For control of *Echinochloa* spp., spray fenoxaprop ethyl 9% @ 625 ml/ha or propaquizafop ethyl 10% @ 625 ml/ha (or) quizalofop ethyl 5% @ 1.0 l /ha as post emergence spray at 15-20 days after sowing.
- For control of grasses and broad leaf weeds, post emergence spray of imazethapyr 10% @ 500 ml /ha or fomesafen 11.1%+fluazifopbutyl 11.1%@ 1.0 l/ha at 15-20 days after sowing.
- At 25-30 days after sowing, if cuscuta patches exist in field, spray paraquat 24% @ 5.0ml per litre of water on the patches to kill the parasite and to prevent seed setting.
- For control of *Vicia sativa*, spray acifluorfen (16.5%) + clodinafop propargyl (8%) @ 1.0 l/ha as post emergence application at 25-30 days after sowing.

7. GROUNDNUT

- Spray pendimethalin 30% @ 2.5 to 3.75 l/ha or alachlor 50% @ 3.75 to 5.0 L/ha immediately or within three days after sowing.
- For control of grassy weeds, spray fenoxaprop ethyl 9% @ 625 ml/ha or quizalofop ethyl 5% @ 1.0 l/ha or propaquizafop ethyl 10% @ 625 ml/ha as post emergence spray at 15-20 days after sowing.
- For control of grasses and broad leaf weeds, post emergence spray of imazethapyr 10% @ 625 ml /ha at 15-20 days after sowing

8. SESAMUM

- Spray pendimethalin 30% @ 2.5 l/ha or alachlor 50% @ 2.5 l/ha immediately or within three days after sowing
- For control of grassy weeds spray fenoxaprop ethyl 9% @ 625 ml/ha or quizalofop ethyl 5% @ 1.0 l/ha as post emergence spray at 20 days after sowing.

9. COTTON

- Spray pendimethalin 30% @ 2.5 to 3.75 l/ha immediately or within 3 days after sowing
- Spray quizalofop ethyl 5% @ 1.0 l/ha + Pyriithiobac sodium 10% @ 625 ml/ha as tank mixture at 20-25 days after sowing if inter-cultivation is not possible due to incessant rains. Fenoxaprop ethyl 9% or propaquizafop ethyl 10% @ 625 ml/ha can be used in place of quizalofop ethyl.

10. SUGARCANE

- Spray atrazine 50% @ 5.0 Kg/ha (or) metribuzin 70 % @ 1.5 kg/ha immediately or within three days after planting sugarcane sets.

- Spot application of paraquat 24% @ 5 ml per litre of water for the control of emerged weeds at 7-10 days after planting without any problem to planted sets in the soil.
- Post emergence spray of 2,4-D sodium salt 80% @ 2.0 kg/ha (or) 2,4-D sodium salt 80% @ 2.0 kg/ha +metribuzin 70% @1.0 kg/ha at 25-30 days after planting.
- At 75 days after planting, if twining weeds viz., *Ipomoea*, *Convolvulus* are problematic, spray 2,4-D Na salt 80% @ 1.6 kg/ha (or) 2,4-D amine salt 58% @ 1.25 l/ha (or) metsulfuran methyl + chlorimuron ethyl @ 20g/ha as post emergence directed spray.

11. PERENNIAL WEEDS IN ORCHARDS

- Perennial weeds like *Cyperus rotundus*, *Cynodon dactylon* etc. in orchards can be controlled effectively by spraying glyphosate 41% @ 2.5 to 5.0 l/ha dissolved in 500 litres of water using hood. Falling of the spray fluid on young fruit plant foliage should be avoided. Second spray is required when there is re growth of weeds. Application of glyphosate with 1% ammonium sulphate enhances the up take and translocation by weeds.
- Ammonium salt of glyphosate 71% @ 2.5-4.0 l/ha can be used as an alternative.
- If annual grasses and dicot weeds are prevalent or when glyphosate is not available in market, the herbicide paraquat 24% @ 2.5 to 3.75 l/ha dissolved in 500 l/ha of water can be sprayed using hood. Falling of spray fluid on fruit trees should be avoided
- The efficacy of the herbicide depends upon the stage of the weed (should be in active vegetative stage), age and duration of infestation (older and longer duration of infestations may require several repeated sprays on active vegetative growth), soil moisture and type of weed and nature of foliage (surface morphology/ herbicide retention and absorption).

Precautions to be taken while applying the herbicides

1. Before applying / selecting a suitable herbicide and its dose, information on cropping system, weed growth stage, weed species and density, soil type, crops around are to be considered.
2. Herbicides need to be applied for the recommended crops in recommended rates /dose and by recommended method only
3. New / unknown herbicides should not be used/recommended without prior knowledge of its mode of action and residual effect.
4. Separate sprayer need to be maintained for herbicide spraying, preferably a battery operated knapsack sprayer, with a flat fan/ flood jet nozzle.
5. As the herbicides are also equally poisonous as the other pesticides, proper care need to be taken while handling, spraying & storage.
6. A spray volume of 200 -250 litres of clean water is required for one acre depending upon the stage of the crop. While spraying care is to be taken not to overlap the area already sprayed.
7. Herbicide spraying may be avoided if the crop is under moisture stress or when the wind speed is high (> 10 kmph) or temperature is high or when rain is expected.
8. In an intercropping system, the herbicide need to be selective for both the component crops. Spraying of Acifluorfen 16.5% + clodinafop propargyl 8% (Iris, patela) in redgram + greengram/blackgram inter cropping, may cause damage to redgram crop.
9. Tank mixing of 2 or more herbicides or with other pesticides need to be avoided with out a valid recommendation.

Common name, trade name, active ingredient and approximate cost of the herbicides included in the recommendations.

S.No.	Common Name	Trade Name	% Active ingredient	Approximate Rate (Rs./Unit)
1.	Alachlor	Lasso, Alatop	50%EC	510/1
2.	Anilophos	Aniloguard, Arozin, weedonil, Anildhan	30 %EC	300/1
3.	Atrazine	Atrataf, Solaro, Milzin, Surya,Atratop,Atrafil,Ultrakem	50 % WP	350/ Kg
4.	Butachlor EC	Butachlor, Trapp, Teer, Machete.	50 %EC	200/1
5.	Butachlor	Butachlor (G)	5 % Granules	25/Kg
6.	Glyphosate (IPA salt)	Glycel, Weed off, Noweed, Glyphos, Brake, Round up, Clean up,	41%SL	300-350/1
7.	Glyphosate (Ammonium salt)	Excelmera, Glyfos dekor, Allkill	71%SG	500/kg
8.	Paraquat	Gramoxone, Uniquat, Paralac	24% EC	500/1
9.	Pendimethalin	Stomp, Pendiguard, Pendiherb, Pendistar, Tatapanida, Bond	30%EC	550/1
10.	Pendimethalin CS	Stomp xtra	38.7 EC	550/700 ml
11.	2,4-D EE	Agrodone conc. 48, Herbonil	36% EC	250/1
12.	2,4-D EE	Agrodex and Knock weed granules	4% Granules	25/Kg
13.	2,4-D Na salt	Fernoxone, Weed mar, Salix	80% WP	350/Kg
14.	Oxadiargyl	Topstar, Oximain	80 % WP	250/35 g
15.	Oxyfluorfen	Goal, Oxygold, Galigan, Kroll	23.5%EC	1800/1
16.	Pretilachlor	Rifit, Eraze, Preet, Pretiherb	50%EC	400/1
17.	Fenoxaprop ethyl	Whip super, Fenixasil, Dell power	9%EC	1500/1
18.	Cyhalofopbutyl	Clincher, Wrap up, Dentil	10% EC	1800/1
19.	Quizalofop ethyl	Targa super	5%EC	1750/1
20.	Metribuzin	Tatametri, Sencor, Tribute, Metriagon	70%WP	1000-1500/kg
21.	Pyrazosulfuron ethyl	Saathi	10% WP	210/80g
22.	Imazethapyr	Pursuit, Lagam, Dinamaz, Perfect, Weedlock	10 % EC	1750/1
23.	Bispyribac sodium	Nominee gold, Tarak, Edora	10%EC	600/100 ml
24.	Pyrithiobac sodium	Theme, Hitweed, Rife	10%SL	2000/1
25.	2,4-D amine salt	Weedmar super, Dura	58%EC	400/1
26.	Ethoxysulfuron	Sunrice	15%WDG	250/50gm
27.	Propaquizafop	Society, Agil, Opal	10 % EC	1600/1
28.	Metsulfuron methyl (10%) +chlorimuron ethyl (10%)	Almix	20% WP	190/8g
29.	Sodium salt of Acifluorfen16.5% +	Iris, patela	24.5% EC	490/400ml

	clodinafop propargyl 8%			
30.	Topramezone	Tynzer	33.6% EC	1500/30ml
31.	Tembotrione 34.4% SC	Laudis	34.4% SC	1500/115 ml
32.	Bensufuron methyl (0.6%) + pretilachlor (6.0%)	Londax power	6.6% Granules	850/4kg
33.	Fomesafen 11.1% + fluaz ifopbutyl 11.1%	Fusiflex	22.2% SL	640/400ml
34.	Propaquizafop 2.5% + imazethapyr 3.75%	Shaked	6.25	600/500 ml
35.	Halosulfuron methyl	Sempre	67.5 % WG	1800/36g

POST HARVEST TECHNOLOGY

In order to get remunerative price to the agricultural produce, farmers have to attend certain primary processing operations like winnowing, cleaning, drying, grading, polishing, milling *etc* before it is sold to the trader or processor. There is a need to adopt appropriate post harvest technologies for cost effective, time and labour saving towards enhancement of quality and marketability of the produce by value addition and by-products utilization, besides reducing post harvest losses.

Rice

Winnowing machines for grain cleaning

Hand and power operated (Power tiller, tractor or small engine operated) winnower can separate chaff, dust etc. from grain. About 500-800 kg of grain can be winnowed in one hour. These machinery are useful during unfavourable weather conditions.

Husk fired furnace dryer for drying of paddy

A half-ton capacity husk fired furnace batch type dryer developed at Post Harvest Technology Centre, Bapatla centre can dry moist paddy of 25% moisture content to 13% moisture content in 8-9 h. It is very much useful when sun drying is not practicable during inclement weather conditions of rainy season and cyclones.

On-Farm Paddy dryer for managing high moisture paddy

A 5 Ton capacity On-farm Paddy has been developed at Post Harvest Technology Centre, Bapatla in collaboration with M/s Kardi Dryers Pvt Limited, Chennai for management of combine harvested high moisture paddy. Extensive trials were conducted and custom hiring of the dryer was also arranged to the farmers. The farmers expressed their satisfaction on the performance of the dryer and seed germination was also found good. The following are the salient features of the dryer.

Salient features of On-Farm Paddy Dryer

S.No.	Description	Salient Features
1.	Type	Mobile - Flat bed – Non Mixing type Paddy dryer (Mixing mechanism Optional).
2.	Capacity	5 ton (Optimized for mobile model).
3.	Power source	Genset / 3 phase AC current.
4.	Loading and Unloading	Loading: Manual/Elevator mechanism. Unloading: Gravity discharge chutes.
5.	Drying time	29% (IMC) – 12% (FMC) – 13.5 -15.0 h. 24% (IMC) – 12% (FMC) – 6 - 8 h.
6.	Fuel consumption	Kharif: 45 – 60 lt (both for Genset and fuel burner). Rabi: 20-30 lt (both for Genset and fuel burner).
7.	Milling tests	Milling Recovery: 62-63 %, Head yield – 58-59 %, Broken – 3-4 %.
8.	Economics (Diesel Run)	Total operating costs Kharif: Rs. 3937/ batch or Rs. 59/ bag of 75 kg or Rs. 0.78/kg. Rabi: Rs. 2287/ batch or Rs. 34/ bag of 75 kg or Rs. 0.46/kg.

		Total costs Kharif: Rs. 6019/ batch or Rs. 90/ bag of 75 kg or Rs. 1.20/kg. Rabi: Rs. 4369/ batch or Rs. 65/ bag of 75 kg or Rs. 0.87/kg.
9.	Benefit Cost Ratio	Kharif:1.47 Rabi: 2.02.
10.	Payback period	5 years

Biochemical changes in paddy up on aging

Paddy stored up to 10-12 months was found with improved qualities of milling and culinary properties. However, beyond 18 months of storage, there is deterioration in its milling and culinary properties.

Batch type rice bran stabilizer

Stabilization of rice bran with rice bran stabilizer at 100°C for 10 minutes controls the increase in free fatty acid up to 28 days in storage, by inactivation of lipase enzyme. This facilitates extraction of edible grade oil, which helps in better utilization of rice bran, the by-product of rice milling industry.

Pulses

Safe storage of pulses

Pulses can be safely stored in nylon bags, polythene lined gunny bags for 6 months provided the grain is properly dried before storage. Mixing of 250g of edible oil per quintal of pulses prevented pulse beetle damage up to 300 days of storage.

Sand layer technique for storage of pulses seed

Keeping sand layer of 3 cm over pulses grain such as redgram, blackgram and greengram while filling the inter grain spaces successfully prevented bruchid infestation when stored in plastic bins (50 l capacity). With slight modification of these plastic bins by providing aeration through small holes at bottom level and secured with nylon net, pulses seed could be stored for more than one year without any deleterious effect on germination. A layer of sand is also to be kept at the bottom so as to cover the holes on which about 45 kg of pulses seed can be placed. The germination of pulses (blackgram (93.11%), greengram (84.67%), redgram (91.78%) stored under sand layer was well maintained without any grain damage after six months of storage. On the other hand, bruchid infestation and decrease in germination (80.33, 73.83 and 59.33% respectively) was noticed in gunny bag stored seeds. Large sized earthen pots can also be used with this technique.

Mini Dhal Mill

The PKV mini dhal mill was developed for milling of all types of pulses *viz.*, redgram, blackgram, greengram and bengalgram. The machine essentially consists of feed hopper, carborundum roller, grading screens, conveyer for mixing oil to the scarified grains and a plate mill for splitting dehusked round dhal, thus mechanizing all the processing operations in dhal making. It will separate dehusked wholes. It can run with a 2 hp motor and can mill 110 to 125 kg of pulses per hour with 35% to 40% wholes and 35% to 40% splits recovery, thus about 76-80% dhal was recovered.

TNAU-Power operated mini dhal mill The mini-dhal mill was tested. It is capable of splitting 30 kg of blackgram per hour with a recovery of 83.5% split half grains with 12% of broken. In respect to greengram, it can mill 32 kg/hr with recovery of 80% splits and 17% broken.

Groundnut

Drying and storage structures

Groundnut pods are to be dried to less than 9% moisture for safe storage which can be stored up to 6 months without aflatoxin contamination and loss of viability. The groundnut can be stored better in 1) loosely knitted gunny bags 2) compactly knitted gunny bags, 3) nylon bags and 4) polythene lined gunny bags.

Viability of groundnut in storage

TMV-2 variety of groundnut maintained high viability (83%) with lesser fungal growth (16%) at 240 days of storage while the viability was least in K-150 (24%) followed by K-3 (21.6%) indicating their unsuitability for storage as seed. The viability was 79% in K-1186, 73% in K-153 and 67% in K-1143 at 180 days of storage. However the viability of these varieties drastically decreased to below 35% by 240 days of storage.

Turmeric

Mobile Turmeric Steam Boiler

The mobile turmeric boiler of 1000 kg/hr capacity was developed by PHTC, Bapatla. The studies revealed that the curcumin content was well stabilized in this method compared to open cooking *bana* method and the quality is superior. Details of experimental results are as follows.

Capacity of cooking	:	1 ton/ hr.
Cooking time	:	10-12 min.
Steam pressure	:	2 kgf/cm ² (140°C).
Fuel consumption	:	6.3 lph.
Moisture initial	:	75% (w.b).
Moisture final	:	78% (w.b).
Drying time	:	12 days.
Operation cost	:	Rs.1.14/ kg raw rhizomes.

Power operated turmeric polisher

With suitable alterations and further attachments like 2 hp motor, V-belt and chain drive mechanism and gear system, the hand operated turmeric polisher was converted into power operated turmeric polisher. The power operated ANGRAU Turmeric polisher is run at 30-32 rpm and can polish about 600-700 kg of turmeric in an hour with 98% polishing efficiency.

ANGRAU Turmeric Grader

The ANGRAU turmeric grader designed and developed by this centre can grade about 400 kg of turmeric in an hour into four fractions namely bulbs, fingers (3 cm length and above), Polishable Nali (2 to 3 cm length) and un-polishable Nali (less than 2 cm length) in a single pass, thus eliminates tedious and laborious manual grading. This also facilitates better quality and value addition to get higher remunerative price.

Chillies

Conversion of Tobacco barns for chilli drying

Ten to twelve quintals of ripe chillies can be loaded in the existing tobacco barns to dry chillies in one batch. G.I. wire mesh trays of size 105 x 75 x 7.5 cm are suitable to hold chillies on the existing tiers. Each tray can be loaded with 7 to 8 kg of ripe pods. Drying time required to reduce moisture from 75 to 10% (w.b.) vary considerably depending upon whether the chilli is hybrid with thick pericarp (eg. Wonder hot) or varieties with medium to thin pericarp (eg. LCA 334). The former takes about 50 hours to dry whereas the latter type takes about 40 hours only. The temperatures ranging from 50°C to 55°C are appropriate for drying chillies. The open yard sun drying takes 12 to 15 days in comparison to barn drying method. The cost of barn drying is approximately Rs.1.50-2.00 per quintal of dry chilli. The percentage discoloured pods can be

reduced to about 3.5 to 4% in barn dried produce in comparison to 9-10% in open yard sun drying. The barn drying method has the advantages such as; 1) quality product with good colour retention and free from external contamination 2) less number of discoloured pods (Talukaya) 3) Reduction in drying time 4) Drying can be accomplished even during unforeseen rains particularly early in the chilli season i.e., December to February to fetch remunerative price.

Drying of chillies in a Modified poly house solar dryer

Modified ANGRAU poly house solar dryer of size 40 x 10 x 3.6 m has been developed at Post Harvest Technology Centre, Bapatla to dry about 120 quintals of ripe chillies. Drying can be accomplished in 7-9 days. Turbojet ventilators have been provided for top ventilation. Side ventilators have been provided to draw fresh air into polyhouse either to bring down the temperature exceeding 50°C or relative humidity less than 85%. The technical details of the Modified ANGRAU Polyhouse Solar Dryer are given below

S.No	Description of item	Technical specifications
1.	Main features of polyhouse (400 sq.m or 3600 sq. ft)	
a	No of spans in a polyhouse	Single.
b	Shape	Arch.
c	Length	120 ft.
d	Width	30 ft.
e	Eave height	8 ft.
f	Rise	4 ft.
h	Bay width	12 ft.
2.	Structure	
		Hot dipped Galvanized steel lipped channel structure which is having galvanization thickness 80 microns.
a	Purling	1” size ID Pipes class B @ 2.30 kg/m.
b	Hoops	2½ “(65 mm) OD class B @ 6.80 kg/m.
c	Columns	2½ “(65 mm) OD class B @ 6.80 kg/m.
d	Cross members	1½ “square pipe @ 3.76 kg/m.
3.	Cladding material	
a	Single layer UV stabilized polythene film	200 microns thick.
b	Light transmission	81%.
c	Thermal conductivity	Up to 10 w/mk.
4.	Top Ventilation	
a	Turbojet ventilator- 12 No	Throat diameter 1½” and other specifications as given in annexure.
5.	Side ventilation	
a	Sliding door Ventilators – 24 No	20 ft X 1½ ft throughout the polyhouse.
6.	Shading	
a	External shading system	50% shading net with rolling arrangement.
7.	Civil works	

	a	Foundations	6 ft ground bore of dia 1½ ft filled with concrete mix 1:3:6 and columns of dia 2½ welded with 12 mm rods on the periphery randomly placed upto a depth of 5 ft from ground for proper anchoring.
	b	Sidewalls (Optional)	Construction of sidewalls with cement bricks of size (12" X 6" X 8") throughout the periphery of the polyhouse to a height of 2'(6" below ground level and 18" above the ground) on Plinth beam of size 6" X 6" constructed with RCC M15 grade with longitudinal reinforcement with 10 mm dia HYSD steel with transverse reinforcement 6 mm dia rings with c/c spacing of 9" including 1' earthwork excavation.
8.	Other accessories		
	a	Protrays (1440 No), Silpauliin cover	
	b	Cost of supply of material and installation charges	Rs. 5,88,000/- (Optional item: Rs. 45,000).

Uses of adopting the technology

- Protection from any unforeseen rains.
- Good colour and reduced number of discolored pods.
- Product free from dust and other physical contaminants.
- Drying can be completed in half of the time required in farmers method.
- Timely drying operation to get premium price.
- During off season, polyhouse can be used to raise chilli nursery or grow coriander or any other leafy vegetable crop by replacing polyethylene film with 50% agro shade net.

Chilli storage

Chillies stored in amber coloured polythene bags were found to retain colour for longer period of storage. Mechanically dried chillies showed higher colour value in chillies during storage than that of open yard sun dried produce.

Chilli seed extractor

The TNAU chilli seed extractor operated at 46-50 kg/hr capacity is particularly suitable for extracting seed from smaller lots without intermittent cleaning. PKV chilli seed extractor was found to be effective to obtain clean seed and the capacity of the extracting machine is around 100 kg/hr. The extraction efficiency for both the equipment is in the range of 96 to 99%. The high capacity chilli seed extractor is useful for seed producers and big farmers.

Compaction and bagging machine for chillies

Conventional method of dried chilli compaction and bagging is normally done by farm labourers, with one person continuously trampling the dried chillies. It involves drudgery and gives burning sensation to the labourers. The productivity of the conventional method by employing three labourers is 6 - 8 bags/h and time required for bagging is worked out to be 10 min per bag. A bagging unit has been designed and developed at Post Harvest Technology Centre, Bapatla for Mechanical Compaction and Bagging of dried chillies. The capacity of the unit has been evaluated as 20 bags/h. The time of operation was found to be 3-3.5 min using machine. The cost of operation of conventional and mechanized compaction and bagging

worked out to be Rs. 30 per bag and Rs. 18.30 per bag respectively. The productivity of the machine in compacting and bagging was calculated to be 150% and a saving of Rs. 11.70 per bag over conventional method. The mechanical compaction and bagging unit is very much useful for bagging of dried chillies.

Others

Agricultural waste fired dryer for chillies and other crops

- A two quintal capacity chilli dryer designed and developed at this centre can dry ripe chillies from 70% moisture content to 15% moisture content in 24 hours at 45 – 50°C drying temperature compared to 12-15 days in open yard sun drying. The chillies dried by this dryer retained colour for a longer time during storage compared to sun dried produce and are dust-free with high quality and appearance. Drying can be done from the crop residue or paddy husk. This dryer could be used as multipurpose dryer for drying other crops like turmeric, groundnut and coconut.
- Drying of turmeric using Agricultural waste fired dryer took 58 hours to dry turmeric from 79.24% to 12.5% moisture content at 45°C temperature against 168 hours of time taken for the similar level of drying in open yard drying.
- The Agricultural waste fired dryer was also evaluated for drying groundnut at 40-43°C and it took 25 hours compared to 4 - 5 days in open yard sun drying for bringing down the moisture content from 28% to 8%. There was no adverse effect on germination of the seed after drying by the dryer.

Fuel Briquetting machine

Fuel Briquetting machine is tested for its performance evaluation. Locally available crop residues such as paddy husk, maize, chilly stacks, groundnut shells and Bengal gram stacks etc are being used as raw material for making the briquettes. The Engineering properties like Bulk density, calorific value, ash content, moisture content of these raw materials before and after briquetting were determined. Briquettes made with rice husk, groundnut shells, chilly stacks, maize stacks burned for long duration and can be used in agro dryers to reduce operating cost and to save conventional fuel. Economics of fuel briquetting machine is studied. Cost of production of briquettes Rs. 4.15/kg.

Chemical treatment of copra to prevent fungal damage

Mature coconut halves treated with solutions of 1% acetic acid, sodium bicarbonate or sodium chloride protected the copra from spoilage due to fungal infection.

Storage containers for storage of tamarind

Tamarind gained moisture when stored in mud pots and gunny bags with reduced total acidity compared to the produce stored in polythene bag, tetra pack or glass bottle. The acidity of the samples stored in tetra pack was highest followed by polythene bags, whereas it was least in case of the samples stored in gunny bags followed by mud pots. None of the structures however could prevent discolouration of stored tamarind as it is temperature dependent.

MANAGEMENT OF PROBLEMATIC SOILS AND WATER

Saline Soils

- Leaching of water-soluble salts with good quality water.
- Application of P to saline soil is necessary to maintain soil fertility status and to reduce the chloride toxicity for plants.
- Application of organic manure is essential.
- Best results may be achieved by using optimum combination of organic manure, bio-fertilizer and chemical fertilizer (INM).

Alkali soils

- Gypsum or other chemical amendments like pyrites are to be applied.
- Passing sodic water through gypsum beds is best.
- FYM application should be accompanied by the gypsum application.
- To mitigate the adverse effect of alkalinity, application of FYM without gypsum will not have much use.
- Gypsum should be applied @ 500 kg/ha for each crop especially where RSC waters are used for irrigation. It varies with the type of soil.
- Application of 25 percent extra Nitrogen is needed as compared to the normal condition.
- An extra dose of zinc sulphate @ 25 kg /ha should be added particularly to the rabi crops grown with alkali water.

I. Classification of ground water quality for irrigation

Water Class	<i>Eciw (dS/m)</i>	SAR _{iw} (m mole/l) ^{1/2}	RSC (meq/l)
A. Good water	< 2	Upto 10	< 2.5
B. Saline Water			
i) Marginally saline	2-4	Upto 10	< 2.5
ii) Saline	> 4	Upto 10	< 2.5
iii) High SAR saline	> 4	> 10	< 2.5
C. Alkali Water			
i) Marginally alkali	< 4	< 10	2.5-4.0
ii) Alkali	< 4	< 10	> 4.0
iii) High Alkali	Variable	> 10	> 4.0

Specifications	Slight to moderate	Severe problem
Boron (ppm)	0.7 - 3.0	> 3.0
Nitrate -N (ppm)	5.0 - 30.0	> 30.0
Flourine (ppm)	1.0 - 5.0	> 5.0
Iron (ppm)	5.0 - 10.0	> 10.0

Source: CSSRI, Karnal

II. Guidelines for using poor quality irrigation water

- Use gypsum when the SAR of saline water is more than 10 or Mg/Ca ratio is more than 3 in irrigation water.
- Use of organic materials in saline environment improves the crop yields.

- Salts in the profile will not be much accumulated when waters of $EC_{iw} < 4$ dS/m are used continuously for irrigation.
- When saline water conjunctively used with canal water, two canal water irrigations.
- followed by one saline water irrigation will not cause any problem both to soil and crop.

SOIL HEALTH MANAGEMENT

Soils are formed by the combination of weathered rock materials with humus. Soil is an important resource to an agricultural country like India. Soils form from the basis of human needs like food, clothing, etc. The prosperity of a country depends generally on the soils of that country.

The following are the soil types in Andhra Pradesh. They are Red Soils, Black Cotton Soils, Alluvial Soils and Laterite Soils.

Red Soils

- Red soils spread over a larger area of the state. They are light and have water retaining capacity.
- They are very less fertile. Red soils are found in Rayalaseema, a large area of Nellore and Visakhapatnam districts, and parts of East Godavari, West Godavari, Krishna, Guntur and Prakasam districts.
- Upland crops like groundnut, redgram, horse gram etc., are grown in these soils. In the areas where irrigation facilities are available Cotton, Tobacco and various varieties of fruits are also grown in Red soils.

Black Cotton Soils

- These soils can absorb and retain water for longer duration. Black cotton soils are found in the Rayalaseema districts, parts of West Godavari, Krishna and Guntur districts.
- Cotton is the chief crop grown these soils.
- Crops like Jowar, Bajra, Korra, Tobacco, Turmeric, Chillies, Sugarcane, Paddy, Plantain etc., are also grown in the irrigated areas.

Alluvial Soils

- Alluvial soils are formed with sand and alluvium brought by river. These soils are spread over the deltas of Krishna, Godavari and Penna.
- These are very fertile soils. Paddy, Sugarcane, Plantain, Guava, Lemon and Oranges are grown in these soils.

Laterite Soils

- These soils are found in parts of Nellore, Visakhapatnam and Srikakulam districts.
- These soils are less fertile. Mango, Cashew and Tamarind trees are mainly grown in laterite soils. Turmeric and Potatoes are also grown.
- In addition to the above soils, Sandy soils are found along the coastal areas of the state.
- Casuarina and Cashew groves are extensively grown in these sandy soils.

Salient Research Findings

- At Tirupati, it was observed that the average fertilizer N requirement to produce one tonne of groundnut pods was 4.38 kg ha^{-1} and to obtain a pod yield of 33 q ha^{-1} , the requirement was 20 kg N ha^{-1} .
- **Crop specificities** for soil phosphorus fractions: Groundnut: Ca — P.
- Phosphorus utilization by selected cereal, pulse and oilseed crops ranged from 7.6 to 13.5 at flowering and 8.4 to 20.7% at maturity. At harvest, the P utilization among the crops studied followed the order: Sunflower > ragi > bajra > black gram > groundnut > green gram.
- Groundnut removes large quantities of K from soil with the uptake ranging from 45 to 135 kg ha^{-1} .

- It has been observed that the status of K in groundnut growing soils is gradually decreasing because of inadequate K fertilization.
- Responses of this crop were observed to K application when available K₂O level was below 150 kg ha⁻¹ requiring an application up to 40 kg K₂O ha⁻¹.
- **Response ratios** for major nutrients (N:P:K): 27.6, 7.1 and 3.8, respectively, at 20:60:40 for groundnut.
- **Calcium:** The average Ca content in the surface soils of groundnut growing areas in Chittoor district was found ranging from 0.8 to 3.6 percent.
- The mean exchangeable Ca in these soils varied from 2.0 to 4.3 c mol (p+) kg⁻¹ of soil. Calcium was found to positively correlate with pod yield in groundnut.
- When Ca was applied through gypsum to groundnut, it was found to play a complimentary role in boosting the effect of applied S.
- **Magnesium:** The exchangeable Mg content in groundnut growing soils of Chittoor district ranged from 0.30 to 0.54 c mol (p+) kg⁻¹ and its saturation on exchange complex varied from 7 to 15 percent.
- The content of Mg in groundnut plant samples ranged from 0.52 to 0.95 per cent. In general, soils which contain Mg < 1 me 100 g⁻¹ soil or 4 to 15 percent of CEC occupied by Mg are treated as deficient in Mg. Application of Mg was found to increase the concentration of Zn in groundnut and rice crops.

Extent of Sulphur deficiency in soils of different districts

S.No.	Districts	Extent of S deficiency (%)
1.	Kurnool, Chittoor and Anantapur	50 - 60
2.	Kadapa, Nellore, Prakasam and East Godavari	40 - 50
3.	Guntur, Krishna, Srikakulam West Godavari, Vizianagaram and Visakhapatnam	< 30

Management of fertilizer S

- The critical levels of S in groundnut crop were 0.20 per cent in the whole plant and 0.23 per cent in the leaves when grown on Alfisols of Anantapuramu district.
- Among crops, the fertilizer S uptake was higher with ammonium sulphate than with gypsum.
- However, the residual effects were found more with the latter than the former source. Application of S increased protein and oil contents in groundnut.
- In Andhra Pradesh, application of gypsum in two splits of 250 kg ha⁻¹ each as basal and at 30 DAS was found to increase the shelling percentage and yield of groundnut grown on Alfisols of Chittoor district.
- Antagonism was observed between S and Mo in groundnut as increased application of S decreased the Mo content in soil as well as in groundnut plants.
- Since both these nutrients are being absorbed as anions (MoO⁴⁻ and SO₄⁻), they probably compete for the same absorption sites on the roots.

Micronutrients

Zinc (Zn)

- Mean available zinc (DTPA extractable) contents ranged from 0.59 to 2.04 mg kg⁻¹ in soils of different districts of Andhra Pradesh.

- In more than 50 per cent of the districts, more than 50 per cent soils were found deficient in zinc.
- Among the soils, deficiency of Zn is highest in Vertisols and Alfisols (60 to 91%) followed by Inceptisols and Entisols.
- Extent of deficiency was 54 per cent in Rayalaseema and 45 percent in coastal regions of Andhra Pradesh.
- The critical levels of DTPA extractable Zn in soils varied from 0.6 to 1.0 mg kg⁻¹ depending upon soil and test crop.
- The critical level for alluvial clay loams of Krishna district was 0.6 mg.
- The critical level of Zn in plant varied from 16.0 to 21.3 mg kg⁻¹ for groundnut.

Iron (Fe)

- Groundnut exhibits Fe deficiency specifically when the active iron content in leaf is < 10 mg kg⁻¹.
- In a screening experiment on lime induced Fe chlorosis on groundnut varieties, it was observed that the yield reduction was less in TCGS-320 while others (TMV-2, TPT-1, TPT-2 and Vemana) showed reduction in yield with increase in CaCO₃ content in soils.

Boron (B)

- Total B content in groundnut growing soils of Chittoor district ranged from 8.3-13.3 mg kg⁻¹.
- Laterite soils of Andhra Pradesh contained available B contents ranging from 13.8-39.8mg kg⁻¹.

Extent of micronutrient deficiencies in soils of Andhra Pradesh and India

Location	% Samples deficient in					
	Zn	Cu	Fe	Mn	B	Mo
A.P	54	<1	2	2	--	--
India	47	4.8	11.0	4	20	18

Nitrogen, phosphorus and sulphur

- Groundnut (TMV-2) grown on sandy loam soil at Hyderabad showed responses to applied N, P and S in terms of increase in dry matter content and uptake of nutrient (N,P and S), shelling percentage, oil and protein contents besides kernal yield.
- While the nodule number showed a decrease with increase in level of N application, the number increased with levels of P and S applications.
- Application of 40 kg N, 50 kg P₂O₅ and 120 kg S ha⁻¹ resulted in the highest kernal yield (15.43qha⁻¹) of the crop with a shelling percentage of 75.3.
- Combined application of 5 kg Zn+40 kg S ha⁻¹ resulted in 19.3 percent increase in yield of groundnut crop.
- The increase in pod yields of groundnut and blackgram were also witnessed due to the application of 5 kg Zn (as zinc sulphate) and 40 kg S ha⁻¹ (through gypsum).

Nutrient deficiencies in groundnut and their corrective measures

Nutrient	Corrective measures
Phosphorus	26.2 kg P ha ⁻¹ to red soils. 35.0 kg P ha ⁻¹ to black soils. Bring the available P to 17.5 kg ha ⁻¹ taking P fixation into consideration.
Potassium	Soil application of 41.7 kg K ha ⁻¹ if the soil test value is < 125 kg K ₂ O

	ha ⁻¹ .
Sulphur	100 kg S ha ⁻¹ through any S containing fertilizer.
Zinc	Soil application of 50 kg zinc sulphate ha ⁻¹ for normal soils (once in 3 seasons). Soil application of 25 kg zinc sulphate ha ⁻¹ in coarse textured soils. 2 to 3 sprays of 0.2 % zinc sulphate solution at weekly intervals in early stages of crop growth.

N fixing bacteria

- *Rhizobium* inoculation improved the growth, yield and nutrient uptake by groundnut. In case of groundnut, *Rhizobium* was tried along with phyto-hormone precursors (L tryptophan and adenine).
- *Rhizobium* inoculation at low levels of L-TRP increased the growth parameters, nutrient uptake besides available nutrient status.
- Adenine addition did not improve the growth parameters of the crop.
- The results indicated that *Rhizobium* plus L-TRP at 10⁻⁷ M concentration was beneficial to groundnut crop.
- The groundnut crop grown on red sandy loam soil was inoculated with *Bradyrhizobium* strain NC-92.
- This resulted in increase in nodule dry weight in the summer crop while pod yields of groundnut showed increase in all the seasons (*kharif*, *rabi* and *summer*).
- Inoculation and application of micro nutrients significantly increased concentration of N in the shoot tissue of summer crop and N and P uptake by *kharif* crop.
- Application of N at 20 and 30 kg ha⁻¹ increased the nodulation compared to control in the *rabi* crop and increased dry weight in *kharif* and summer crops at 30 and 60 DAS.
- The N levels at 30, 40 and 50 kg ha⁻¹ increased N concentration and uptake in summer crop while application of 40 kg N ha⁻¹ level resulted in increased P uptake and K and S concentrations in summer crop.

Integrated Nutrient Management (INM)

- Nitrogen application at 20 kg ha⁻¹ combined with *Rhizobium* inoculation increased yield, protein and oil contents of J-11 groundnut.
- The pod yield of intercropped groundnut (459 kg ha⁻¹) was also significantly increased due to 100 NPK applied in conjunction with FYM @ 5 t ha⁻¹.
- Results of a permanent manurial trial conducted for 22 years on shallow Alfisols at Anantapur indicated that application of 100 % N (Groundnut shells @20 kg N ha⁻¹) and 100 % N (Groundnut shells @ 20 kg N ha⁻¹) +50 % NPK (10-20-20 kg ha⁻¹) were equally efficient while 50 % N (FYM @ 10 kg N ha⁻¹) was the next best treatment for attaining sustainable groundnut yield (Maruthi Sankar *et al.* 2010).

Cropping Systems

Maize — groundnut

- Among the different combinations tried, application of 75% RDFN+25% N through Vermicompost + 100% P₂O₅ ha⁻¹ resulted in the highest dry matter yield(60.26 q ha⁻¹) at flowering and grain (51.38 q ha⁻¹) and stover (59.77 q ha⁻¹) yields of maize at harvest. Similar results were observed even under greenhouse conditions. The increase in all these parameters was attributed to initial N status of the soil of experimental field.

- Among the treatments tried on maize, the residual effects on groundnut with respect to dry matter yield (22.10 q ha⁻¹) at flowering, kernel (16.36q ha⁻¹) and haulm (34 .0 q ha⁻¹) yields at harvest were highest with the application of 50 % RDFN + 50 % N through Vermicompost and 100 % P₂O₅ ha⁻¹.
- Among the cumulative effects, application of 50 % RDFN + 50 % N through VC + 100 % .
- P₂O₅ to maize and 75 % RDFN to groundnut showed the highest dry matter yield (26.89 qha⁻¹) at flowering, kernel (20.13 q ha⁻¹) and haulm (41.94 q ha⁻¹) yields at harvest. The cumulative effects were found to be more than their respective residual effects on groundnut crop.
- The fatty acid profile was studied and in case of groundnut, the oleic acid was found to be the major fatty acid followed by linoleic, palmitic, arachidic and stearic acids in decreasing order of their concentration. Application of increasing levels of N led to decrease in contents of plamitic and oleic acids while the contents of linoleic acid was increased. However, a definite trend was not observed with stearic and arachidic acids. Application of increasing levels of N led to decrease in contents of plamitic and oleic acids while the contents of linoleic acid was increased. However, a definite trend was not observed with stearic and arachidic acids.
- At the end of sequence, there was depletion of saloid- P and Ca-P contents in control plots while a built up was noticed in Al-P and Fe-P under cumulative effect with an exception to Fe-P, which showed depletion under residual effects.
- The maximum activities of enzymes viz., urease (6.32 ug of NH₄ + -N released g⁻¹ soil ha⁻¹) ,acid phosphatase (43.27 ug of p—nitro phenol released g⁻¹ soil ha⁻¹) , alkaline phosphatase (49.80 ug of p-nitro phenol released g⁻¹ soil ha⁻¹) and dehydrogenase (1.14 mg TPF produced g-1soil d⁻¹) were observed in the treatment 50% RDFN + 50 % N through VC + 100% P₂O₅ to maize and 75% RDFN to groundnut crop showing cumulative effect at the end of sequence.

Salinity tolerant varieties of groundnut

- Groundnut ICGV-87189, ICGV-86309, Girnar-1, ICGS-1, ICGS-5, ICGS-65 and ICGS-44.
- The following **soil and water management practices** will help to reduce the salinity and sodicity problem further and crop growth in such fields will also be better
- Apply 25 % of more N than the recommended.
- Apply organic manures (@ 5 t ha⁻¹) along with zinc (@50 kg ZnSO₄ ha⁻¹) in sodic soils.
- Green manure crops like dhaincha can be grown and ploughed in situ for the reclamation of sodic soils.
- Apply gypsum (at 50 % Gypsum Requirement) on the basis of initial soil test value for the reclamation of sodic soils where the pH is > 9.0 and in black soils growing salt resistant varieties suitable to the area concerned.

Quality of waters

- In the ground water survey carried out in **11** districts, the **salinity problem** was observed in Guntur (18.3 %), Prakasam (18.6%), West Godavari (16.8 %), Krishna (15.8 %), East Godavari 10.7 %) and Nellore (9.4 %) districts, while it was low in Anantapuramu (1.7 %), and Kurnool (6.9 %) districts.

Classification of ground water in different districts of Andhra Pradesh was also done

- Out of 684, 166, 837, 140, 825, 501, 621, and 927 samples collected from Anantapuramu, Prakasam, Guntur, East Godavari, West Godavari, Krishna, Kurnool and Nellore districts

and examined, 306, 62, 537, 105, 685, 331, 437, and 340 samples, respectively, were found of good quality. The remaining samples were showing different degrees of salinity and sodic nature.

- The underground waters used in different sugar factory areas in North Coastal Zone viz., Thummapala (Anakapalle), Chodavaram, Etikoppaka, Bhimisinghi, Amudalavalasa, Payakaraopeta, Chelluru, Pithapuram and Samalkota, varied degrees of salinity were noticed while sodicity problem was not prevalent. Such observations were also made in and around Empee Sugars and Chemicals Ltd. in Nellore district.

Management practices suggested for irrigation with saline waters

In order to overcome the adverse effects of using such bad quality waters in coastal saline areas, certain management practices were suggested. These include

- Incorporation of dhaincha @ 5 t ha⁻¹ or FYM @ 15 t ha⁻¹ + 50 % of the recommended dose of Nitrogen.
- Adopting closer spacing with 50 percent more plant population than normal.
- Application of 50 percent more N and P than the recommended dose.
- Conjunctive use of two canal irrigations followed by one saline water irrigation to crops.
- Avoiding use of saline irrigation water at germination, flowering and grain filling stages of the crops.
- Application of gypsum @ 500 kg ha⁻¹ at pegging stage of groundnut.
- Combined application of 2.5 t ha⁻¹ of green leafy manure + 2.5 t ha⁻¹ of FYM to paddy crop.
- *Improved Doruvu* technology has been developed for horizontal skimming of fresh water floating over the saline ground water with tile drains laid out for this purpose in coastal sands to irrigate vegetables, flowers and raising rice, tobacco and *Casuarina* nurseries.

Soil Pollution

- Soil application of Fly ash at 10 t ha⁻¹ and application of N, P and K at recommended doses resulted in good performance of groundnut crop grown on a sandy loam soil.

Land management practices

- The penetration resistance was found lower in broad bed and furrow (BBF) system by 9.3 and 15.5 kg cm⁻² than that were observed in ridges and flat beds, respectively.
- The total porosity of soil in BBF was higher by 4.0 and 8.3 percent than the ridges and flat beds, respectively.
- Maximum pod yields of ground nut ICG (FDRS) 10 and ICGS-11 varieties were observed in BBF and it was more by 11.9 at 20.5 percent than with ridges and flat bed systems, respectively, which was attributed to the increase in soil moisture retention, decrease in BD and penetration resistance.
- Developing surface management techniques to reduce soil structural problems and enhance profile moisture storage, thereby decreasing deep percolation losses and modifying solute movement, tillage, application of residues and conditions of surface and surface roughness are important considerations.

Effect of conservation tillage

- Formation of ridges and furrows along the contours with *khus* grass (vegetative barrier) was found to result in highest reduction in run off (90.2%) and soil loss (91.95%).
- Water use efficiency (kg/ha-mm) was more in deep tillage with *khus* (6.96) followed by deep tillage (6.02) and ridges and furrows with *khus* (6.28) against sowing along slope (4.57).

Effect of physical environment on certain plant parameters

- In case of groundnut, a population density of 5.0 lakh plants ha⁻¹ under favorable rainfall conditions increased the degree of aggregation by 4.41 percent , mean weight diameter by 13.73 percent and hydraulic conductivity by 13.99 percent over a population density of 3.33 lakh plants ha⁻¹ .
- The improvement was attributed to increased root growth, which favored soil aggregation.
- Plant population had also influence on ET as computed by different formulae /equations.
- Seasonal crop ET increased significantly with increase in plant population density.
- Significant correlations were observed between crop ET and evaporation from USW Class A Pan. At the plant population density of 5 lakh ha⁻¹, the highest pod and haulm yields of groundnut were recorded even for per unit quantity of water used resulting in maximum net returns and high cost: benefit ratio.

Influence of applied nutrients on soil physical conditions

- Tillage with rotovator and tractor drawn implements on a loamy sand soil put to groundnut and application of 90 kg P₂O₅ ha⁻¹ to the crop showed significant increase in root growth and dry matter accumulation.
- Groundnut crop grown on red chalka soil showed response to application of zinc due to not only supply of this nutrient but also because of certain favorable effects on soil physical parameters, specifically due to improvement in degree of aggregation.

Soil moisture studies

- Very few studies were carried out on the soil moisture to indicate its support to crop growth, specifically in drought prone areas.
- In place of soil moisture, available water capacity is reported. The latter is dependent on the amount and intensity and distribution of rainfall, infiltration, permeability, type of clay minerals, texture, depth and gravel contents in soil.
- The data were generated for all the 23 districts on the available water capacity by the NBSS & LUP, Nagpur (Reddy et al.,1996) and that information was utilized to work out the length of growing period (LGP) of crops. The ratings followed were:

Length of Growing Period (LGP) Rating	Available water capacity (mm/m)	% of Total area in A.P
Very low	< 50 mm/m	22.33
Low	50 to 100 mm/m	13.24
Medium	100 to 150 mm/m	35.32
High	150 to 200 mm/m	5.81
Very high	>200 mm/m	14.72

Note: The high and very high categories have potential to support the growth of long duration crops.

The management of soils for increasing the available water capacity includes

- Deep tillage management.
- Early sowing of crops.
- Choice of drought tolerant crops and their varieties which can use moisture efficiently.
- Maintaining optimum plant population & moderate use of fertilizers.
- Inter/mixed cropping as an insurance against crop failure.
- Timely weeding and pest control.
- Ratooning of the drought affected crops on receipt of rain.

- Sowing alternate crops in case of crop failure during midseason.
- Impounding of rain water through farm ponds for supplemental irrigation to save the crop and also for recharging the ground water.
- Alternate land use systems such as agro forestry agri-horticulture, silvi-pasture and alley cropping and in situ moisture conservation by application of mulches.
- In the South of A.P, the probabilities of rainfall are low and also the soil moisture is available for a shorter duration, especially at Kurnool and Anantapuramu.
- At Kurnool, the moisture adequacy, which is a reliable index for knowing the availability of water to the crop, value was 0.75 for 8 weeks, 12 weeks at Ongole, 4 weeks at Anantapuramu and 12 weeks at Kadapa. These observations indicate that in the South, the crops are subjected to drought more frequently.
- The models of yield through soil moisture at 30 ,60 and 90 DAS had coefficient of determination in the range of 0.13 for 50 %N (FYM@ 10 kg N ha⁻¹) to 0.45 for 100 % NPK (30-40-40 kg ha⁻¹) + ZnSO₄ @25 kg ha⁻¹.
- The effect of soil moisture on pod yield was negative on 30 and 60 DAS, while it was positive on 90 DAS (Maruthi Sankar et al.2010). The rate of change was positive at 90 DAS with values ranging from 1.42 for control to 6.30 for 100 % NPK (20-40.40 kg ha⁻¹).

Available water capacity in soils of different districts

S. No.	District	Available Water Capacity (mm/m)	S. No.	District	Available Water Capacity (mm/m)
1.	Anantapuramu	114.23	8.	Nellore	81.53
2.	Chittoor	75.47	9.	Prakasam	95.71
3.	Kadapa	66.91	10.	Srikakulam	99.47
4.	East Godavari	106.53	11.	Visakhapatnam	108.27
5.	Guntur	112.93	12.	Vizianagaram	110.00
6.	Krishna	74.40	13.	West Godavari	101.86
7.	Kurnool	120.77			

Soil management aspects

Alfisols

- This is the most dominant group covering the red soil areas in Andhra Pradesh. The soils occur in level to gently sloping areas.
- The soils are usually open with free drainage but show the problems of leaching as evidenced by an ‘argillic’ horizon suggesting that eluviation and illuviation are dominant soil farming processes in these soils.
- Climate, parent material and relief are dominant soil farming factors in the development of these soils.
- The following are some of the main problems encountered in crop production on these soils
 - i) Poor crop stand due to crust formation, rapid drying of surface soil and high soil temperature.
 - ii) Poor crop growth due to unreliable soil moisture supply, low soil fertility, soil workability problems and compact sub soil layer (argillic horizon).
 - iii) Declining land productivity resulting from high soil loss through erosion due to poor crop canopy and crusting, sealing and consolidation.

Vertisols

- The management of Vertisols includes overcoming the physical constraints such as narrow range of soil water content for tillage, high erodability, tendency to become water logged and poor trafficability.
- These soils are hard when dry and very plastic when wet. Tillage at inappropriate moisture range will lead to compaction of subsoil.
- The farmers generally adopt rainy season following due to difficulties in achieving proper tith.
- The technologies developed for management of these soils include proper land and water management practices to improve water intake, reduce erosion and run off etc. ,
- Land shaping such as preparation of broad bed and furrows (BBF) at 0.4 to 0.6 percent gradients, carrying out primary tillage soon after harvest of post rainy season crops, working with blade harrow to shatter the clods, dry sowing of crops before the onset of monsoon rains, including legumes in cropping systems and using high yielding stress tolerant varieties of crops.

Entisols

- This group of soils are seen in coastal sandy areas of Visakhapatnam, East and West Godavari, Krishna, Guntur, Prakasam and Nellore districts.
- Deltaic alluvium of East and West Godavari, Krishna, Guntur districts and the red soils region of Guntur and Nellore districts also belong to Entisols.
- The relief and parent material are limiting factors in development of these soils. At high reliefs, erosion is commonly seen even at low rainfall resulting in loss of soil.
- As these soils are characterized by low water retention, low water storage capacity and high infiltration, roller technology (passing 200 to 1500 kg weight roller for 2 to 6 times depending upon the soil type) may be better to improve the yields of crops.
- There is requirement of frequent irrigation and scope for using irrigation efficient systems is more.
- Manuring is also important and sources of nutrients soluble in water need to be applied in small quantities and frequently.
- Even foliar application is also needed due to openness of soils. Surface mulching is useful to conserve the soil moisture.
- The possibility of soils becoming alkali is not that fast because of which there is scope for using inferior quality waters for irrigation.

A brief detail about Soils in Andhra Pradesh

S. No	Name of the Zone	District	Head Quarters	Geographical Area (Lakh ha.)	No. of Mandals	Soil Type	Normal Rainfall(mm)/ Important crops grown
1.	North Coastal Zone	Srikakulam, Vizianagaram, Visakhapatnam	Anakapalle	18.5	88	Deltaic alluvium, Red soils with clay, BC soils, Red loams, coastal sands, saline soils	1000 – 1100 Sugarcane, rice, maize, groundnut, Mesta, Ragi, sesamum, Coconut, Mango
2.	Godavari Zone	East Godavari' West Godavari	Maruteru	17.5	96	Red soils with clay base, pockets of acidic soils, laterite soils.	1000-1200 Rice, maize, pulses, groundnut, sugarcane, coconut, cashew nut, Mango
3.	Krishna Zone	Krishna, Guntur, Prakasam	Guntur	37.7	161	Chalkas, red sandy soils, Dubbas, Deep red loamy soils and very deep BC soils.	600-1000 Rice, cotton, maize, Redgram, pulses, sesamum, groundnut, sugarcane, Lemon, Mango.
4.	Southern Zone	Chittoor, Y.S.R. Kadapa, Nellore	Tirupati	41.7	161	Chalkas, red sandy soils, Dubbas, Deep red loamy soils and very deep BC soils	600-1000 Groundnut, Rice, sugarcane sesamum, Redgram, pulses, Mango, Lemon, and vegetables
5.	Scarce Rainfall Zone	Kurnool, Anantapuramu	Nandyal	36.2	117	BC soils and Chalkas	500-670 Rice, bengalgram, maize, sorghum, groundnut, redgram, pulses, SF, castor, mango, citrus
6.	High altitude and tribal zone	High Altitude and tribal areas of Srikakulam, Visakhapatmam and Vizianagaram	Chinthapalli	18.0	40	Red sandy loams and patches of aerial soils	900-1200 Rice, maize, redgram, coffee, pepper, chillies and horticultural crops

DRYLAND AGRICULTURE

Growing of crops in rainfed situations is known as dryland agriculture. The total geographical area of Andhra Pradesh is 160.2 lakh ha. The net sown area is 67.19 lakh ha, net irrigated area is 28.08 lakh ha. Rainfed area is 39.11 lakh ha and it accounts for 58.21% of net sown area with 60% area under red soils and 25% area under black soils. Among the 13 districts of Andhra Pradesh, Ananthapuramu district is having the highest area under rainfed agriculture (9.65 lakh ha) and top rainfed priority rank followed by Kurnool, YSR Kadapa, Prakasam and Chittoor districts. Variation in crop yields is more in drylands due to non receipt of timely rainfall, early cessation of rains, inadequate and uneven distribution of rainfall and prolonged dry spells during crop periods. Adoption of suitable soil moisture conservation measures and improved management practices will increase yields.

Soil and Water Conservation

Red Soils

These soils are shallow in depth with low water holding capacity. Rainwater is lost as runoff causing erosion resulting in loss of fertile top layer of the soil and nutrients. Research efforts were made to reduce these losses and soil conservation measures were found useful in reducing runoff and soil loss.

- When soil depth is 20 cm or more, deep tillage once in three years helps in better infiltration of rainwater and reduces pest and weed problems.
- Cultivation across the slope reduces runoff.
- If slope is multiple and more than 2%, construction of contour bunds with a cross section of 0.63 m² at 50 m horizontal interval helps in conservation of soil and water. In areas where annual rainfall is more than 750 mm, graded bunds are recommended.
- To avoid water stagnation on downstream side of contour bunds, formation of compartmental bunds with spacing of 15 m x 10 m before emergence of the crop or formation of conservation furrows with receipt of rainfall after 20 days of sowing of the crop help in reducing the water stagnation on downstream side of contour bunds and facilitates better infiltration of water in to the soil.
- Application of shales 300 t ha⁻¹ as surface mulch resulted in increased pod and haulm yield by 24.2 and 25.2 per cent, respectively compared to dryland groundnut. An application of shales results in improvement of soil structure by improving water holding capacity, infiltration rate, porosity and reducing bulk density, which influences the productivity and profitability for about five years once it is applied.
- *In situ* conservation measures like dead furrow in groundnut at an interval of 3.6 m enhances the availability of soil moisture to the crop.
- Intercropping groundnut with mixed pulses like horsegram, cowpea and redgram in 11:1 ratio helps in reducing the runoff losses and increases net returns.

Black Soils

Water holding capacity of black soils is very high. Deep cracking, low permeability and poor drainage are the major problems in these soils. Soil conservation and improved management practices enhance the productivity of dryland crops.

- Formation of graded bunds with a cross section of 0.8 m² is recommended. Formation of a channel with a slope of 0.1 – 0.25 % along the graded bunds and merging these channels in to a grassed waterway help in drainage of water without any soil erosion.
- Formation of ridges and furrows is useful for deep black soils. Sowing should be done on the ridges. Furrows facilitate easy drainage of water.
- Formation of raised bed with 3 m width at 20 cm height help in getting increased yields of crops, as the furrows facilitate better drainage of water.

- Compartmental bunding with 5 m x 5 m before onset of monsoon improve the soil moisture storage capacity and useful for post rainy season crops.
- Application of FYM @ 20 t/ha help in better infiltration of water.

Rainwater Management

Red Soils

- Runoff of rainwater can be prevented by practicing soil conservation measures. Sub soil chiselling with subsoiler improves the water holding capacity of shallow soils and reduces runoff.
- Mulching with groundnut shells @ 5 t/ha within 10 days after sowing of the crop reduces evaporation losses.
- Rainwater collection and storage for subsequent use is known as water harvesting. Water harvesting in farm ponds and subsequent use as supplemental irrigation helps in increasing the yields of rainfed crops. Runoff constitutes 25 % of rainfall in red soils. Water harvested from catchment area of 1.0 ha can be used to irrigate one hectare. Lining of farm ponds can reduce seepage losses. Lining with soil + cement at 6:1 ratio is found reduce seepage losses considerably. A farm pond with dimensions of 10 m x 10 m x 2.5 m can store 250 m³ of runoff water, which can be used for giving supplemental irrigation. A supplemental irrigation of 10 mm through sprinklers at moisture stress during critical stages can increase groundnut pod yield by 25 - 30 %.

Suitable Crops

Red Soils

- Groundnut, sorghum, pearl millet, foxtail millet, redgram, greengram, cowpea, castor and horsegram are suitable crops. Groundnut + redgram, groundnut + castor, sorghum + redgram are the profitable intercrops which help in prevention of crop loss during drought years.

Normal Monsoon Season (June – July)

- Choice of the crops has to be made depending on the time of receipt of rainfall. Castor or redgram can be sown if the rains are received during June. If rains are received during July intercropping of groundnut + redgram is profitable.
- **Delayed Monsoon Season (Beyond July)**
- If rainfall is received during August, the suitable contingent crops are pearl millet, sorghum, greengram, cowpea and horsegram.
- If rainfall is received during September, fodder sorghum, fodder bajra and horsegram are suitable.

Black Soils

- Cotton, chillies, sunflower, bengalgram, tobacco, sorghum, safflower and coriander are suitable crops. Sorghum and sunflower if sown during first fortnight of September.
- Application of zinc sulphate @ 50 kg/ha once in three seasons is necessary, if zinc deficiency is observed.
- Application of ferrous sulphate @ 2 g/l of water, if iron deficiency is observed.

Soil Health Management

- Studies on sheep penning (ITK) at ARS, Ananthapuramu, indicated enhancement of soil fertility significantly with the sheep penning @ 1 sheep /m². Further, the physical, chemical and biological fertility of the soil also improved with this sheep penning in every season for all most all the rainfed crops.

- The basal application of 20 kg N, 40 kg P₂O₅ and 40 kg K₂O/ha are necessary for groundnut and groundnut + redgram. For horsegram, application of 10 kg N and 30kg P₂O₅/ha are necessary.

It is better to apply phosphorus and potassium based on soil test values. For groundnut crop grown in red soils, the following schedule is recommended.

Phosphorous (P ₂ O ₅) (kg/ha)		Potassium (K ₂ O) (kg/ha)	
Available in the soil	To be applied	Available in the soil	To be applied
<20	40	<150	40
20-40	20	150 -300	20
>40	Nil	> 300	Nil

For correcting zinc deficiency in groundnut, spraying of 0.2% zinc sulphate is recommended at 35 and 45 days after sowing.

- Fertilizer application based on soil test values or half the recommended fertilizer (10:20:20 kg N, P₂O₅, K₂O) along with consortia of PSB @ 5 kg + PSF@ 5 kg + AM fungi @ 12.5 kg ha⁻¹ not only enhanced the groundnut pod yield and also reduced the cost of cultivation.
- Foliar spray of Potassium Nitrate @ 5 g per litre of water during peg penetration and pod development stages will not only enhance the quality and quantity of groundnut yields but also increase the groundnut crop life during drysell.

Weed Management

Intercultivation either with bullock drawn harrows or with intercultivation equipment with slim tyres should be practiced at 25 and 40 days after sowing. In areas where labour is a shortage, broadcasting of fine soil mixed with pendimethalin @ 2.5 L/ha or spraying pendimethalin @ 5 mL/L is recommended, within two days after sowing of the crop.

Farming Systems Research

Under farming system where groundnut is a prevalent cropping system, rearing of sheep (ram lambs) for about four months with groundnut haulms alone or stall feeding of haulms + grazing in addition to cultivation of groundnut has been found highly profitable than the cultivation of groundnut crop alone. Besides, provide 65 days of employment after harvest of groundnut. Backyard poultry with improved breeds like Rajasri/Vana Raja/ Gramapriya (20+5) improves livelihoods of small and marginal farmers.

Energy Management

Tractor Drawn Ananta Groundnut Planter: 8 rows

Tractor drawn Ananta planter (8 rows) developed to mechanize the groundnut sowing for timely operation with mechanical advantage and intercropping facility. A 5 cm width covering blade is also fitted behind the furrow openers to cover the furrows after seed placement. The inclined disc plate seed metering mechanism gives correct seed to seed distance and maintains the recommended seed rate of 90 to 100 kg/ha. The seed damage is negligible and placement of seed is at proper depth of 4-5 cm. The field capacity is 6 to 7 ha/day and can cover large area before the soil moisture is dried up. The germination and optimum plant population was possible. The intercropping of redgram or castor can also be sown using Ananta planter along with groundnut sowing. The spring type cultivator of this planter facilitates to sow in stony and pebble slopy soils. The cost of Ananta planter is about Rs.65,000. Ananta planter can also be used with mechanical adjustments for sowing Castor, redgram and chickpea with distinct row to row and seed to seed spacing. Groundnut + redgram Anantha Planter is suitable for groundnut and redgram sowing in 8:1 row arrangement.

Ananta 4-Row Bullock Drawn Automatic Planter

Ananta 4-row bullock drawn automatic planter developed to mechanize groundnut sowing for timely operation with keeping in view of the small and marginal farmers. Main advantage with this planter is low cost of Rs.4,000 towards the seed metering mechanism attachment to local bullock drawn *gorru* for groundnut sowing. Total cost of planter is around Rs. 10,000. The trough feed type seed metering mechanism gives correct seed to seed distance about 10 cm in a row and maintains the recommended seed rate of nearly 100 kg/ha by adjusting the depth gauge in the hopper. It covers 4-rows at a time with 30 cm spacing. The seed damage is nil and placement of seed is at proper depth of 4-5 cm. The field capacity is 1.6 to 2.0 ha/day and can cover large area before the soil moisture is dried up compared to bullock drawn local *gorru* with precise sowing and required seed rate. The weight of planter is only 52 kg, so that two bullocks can easily pull the planter without much stress.

Tractor Drawn Ananta Interculture Implement

Normally weeding in rainfed groundnut is done by *metla guntaka* and *danti guntaka* driven by a pair of bullocks in between rows at 20 and 40 days after sowing or by hand with the help of hand hoe. The tractor drawn interculture implement was developed to mechanize the intercultivation in groundnut for timely and reduce the labour cost. This operation can also help earthing up, moisture conservation and soil mulching. The tractor drawn interculture implement can run in between the row spacing of 30 cm without any plant damage. Its field capacity is 4 to 5 ha/day. The pneumatic small tyres of 8.3" x 32" size were fitted to the rear wheels of the tractor. The tractor drawn Ananta interculture implement with small tyres can run in the groundnut field at a row spacing of 30cm. The interculture implement with 8 tyres was developed with T-shape and V-shape sweeps fitted to the tynes and field tested. The cost of pneumatic tyres and interculture implement with sweeps was about Rs. 55,000.

Tractor Drawn ANGRAU Blade Guntaka

General practice of harvesting is by hand pulling of groundnut crop when the crop comes to maturity. If rain occurs during the crop maturity, hand pulling is easy due to sufficient moisture in soil. However, the soil becomes hard and compacts if there is no rainfall at the time of maturity. The farmers use bullock drawn *madaka* to open the furrow along the rows to loosen the soil and plants are removed from the loosen soil to minimize pod loss. Under these circumstances, the harvesting losses are more even upto 20%. Its field capacity is only 1.0 to 1.5 ha per day. The tractor drawn blade guntaka was developed to perform the harvesting operation easy and more economical. It covers 4 rows at a time. Harvesting can be done at right time to avoid other field losses. The cost of blade guntaka is Rs.20,000. The worn out blade can be replaced with a new one in the blade slot which is fixed to the 6" pipe frame. Its repairs can be attended easily by the local artisans.

Pest and Disease Management

Since the farmers are less resourceful, IPM is a suitable technology. To reduce the cost of pest and disease management, it is better to follow. Continuous monitoring pests and disease duly following forewarnings given based on the weather prevailing during the crop periods in addition resorting to use of chemical only after adopting suitable cultural and mechanical means of management of pests.

Groundnut

- a) **Leaf Miner:** Maximum temperature of more than 33⁰ C and afternoon relative humidity of less than 40 per cent followed by dry spell of more than one-week results in incidence of the pest. If rain occurs, the incidence gets reduced during *kharif*.
- b) **Red Hairy Caterpillar:** Rainfall received between last week of June and September causes the emergence of RHC moths. The emergence is noticed on 2nd day after the occurrence of rainfall of 10 mm and more. If heavy rainfall of 80 mm and above is received in one day during June/July, heavy emergence of RHC will take place at a time

and subsequent emergence will be less. However, the moths emerged during September though they lay eggs, but mortality of eggs and larvae is observed due to the parasitisation and thereby the influence on the crop will be less.

- c) **Late Leaf Spot:** Morning relative humidity of 80 % and more coupled with night temperature around 22°C causes the initiation of the late leaf spot disease on groundnut. If the weather conditions exist for a week, the disease spread will be more. Added to this the leaf wetness index of 2.3 coupled with 10 % LLS incidence requires the control measures.

BEE KEEPING

The equipment required for maintenance of *Apis mellifera* is

- Bee hive box with stand
- Hive tool, Smoker
- Bee veil (for protection of face from bees stinging)
- Bee brush
- Rubber gloves 12" length
- Crystal knife (for removing brood frames)
- Queen excluded sheet
- Aluminium plates of 1" depth and 4" to 5" diameter to keep the legs of the stand immersed in water, to prevent from ants and provide water for bees.

For colonies on *Apis mellifera* contact Principal Scientist (Ento.) & Head, Maize Research Centre, ARS, Vijayarai – 534 475, West Godavari

- The best time for introduction of *Apis mellifera* in the state is from middle of December to middle of January. The cost of each transport hive with five frame bee strength colony is about Rs. 730/-.
- For successful maintenance of *Apis mellifera* colonies, there should be profuse forage, rich in nectar/pollen within a radius of 2 to 5 km for a period of 9 to 10 months. Sunflower, Cotton, Safflower, Sesamum, Mustard, Peas and all cucumber family plants possess flowers with high nectar content. Among plantations, Mango, Guava, Coconut, Tamarind, Ber, Cashew nut, Banana, Citrus, Neem, Eucalyptus, Drumstick and Soap nut are also the source of nectar. Availability of fresh water and formation of Drone congregation centres (5-6) for queen mating may also play an important role in success of bee keeping. Mites infesting the colonies can be controlled by dusting sulphur @ 1.5g per frame on the top bar.